PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XVII CHICAGO, NOVEMBER 1, 1913 No. 21

PLANT OF THE NO. ADAMS GAS LIGHT CO.

Remodeled Central Station Employing Porcupine Boilers and Steam Turbines

WHEN THE MASSACHUSETTS Lighting Co. took control of the North Adams Gas Light Co. Plant, a few years ago, they found a plant sadly in need of rejuvenating in order to put it in shape to operate on a paying basis, and at once proceeded to introduce new and modern equipment. As a result the electric station is one of the show places of the Berkshires. The old plant, consisting of several reciprocating engines enlarged and new machinery installed. But the men in charge of the work planned well and the result is all that could be expected or hoped for under the circumstances; and, today, if one cares to take a walk of about ½ mile from North Adams Depot westward along the Fitchburg Division of the B. & M. R. R. tracks he will find a tidy yard with nice lawns and clean, well-kept buildings and other equipment belonging to one of the most up-to-date combination gas and electric plants in New England.

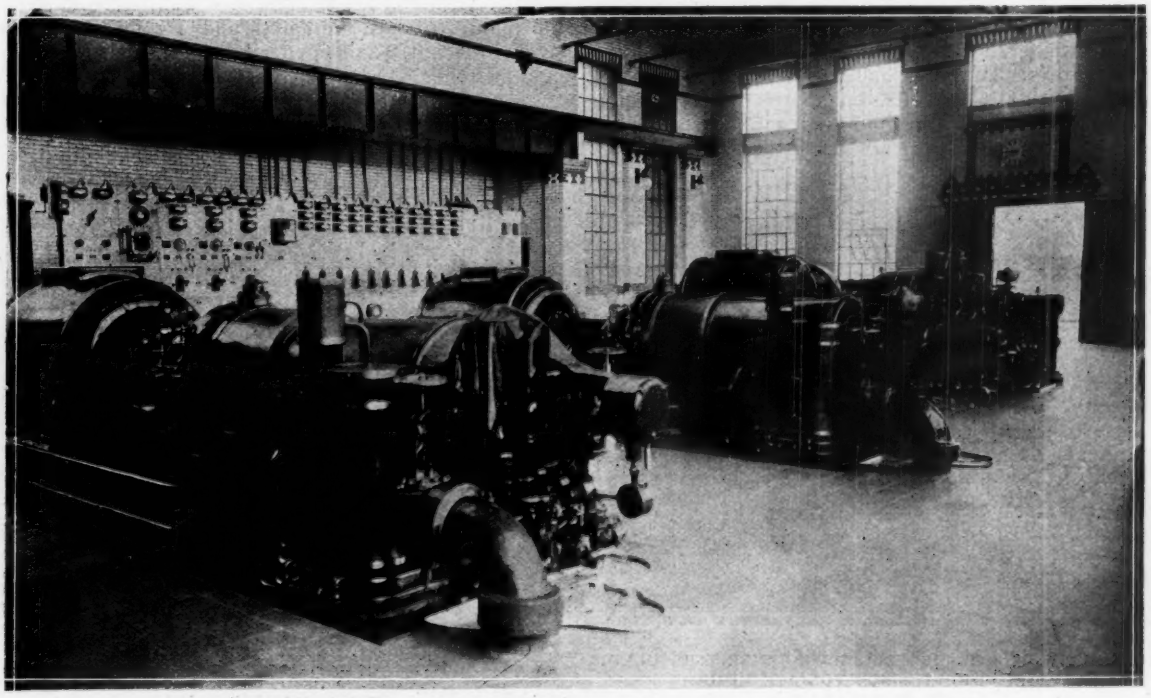


FIG. 1. VIEW IN THE TURBINE ROOM OF THE NO. ADAMS GAS LIGHT CO. PLANT

belted to old style generators of various makes and types, was situated in what is now the basement of the new plant, and the problem to be solved was to keep the old plant in operation until the building could be

The electric station itself is of hard brick construction outside, with a steel and concrete roof. Inside, the walls are of white enameled brick with a floor border of dark green enameled brick rising to the window

ledges. A dado of the same color brick over the windows gives a pleasing interior, and add to this a floor of red square tile on top of a main floor of steel girders and concrete, and you see the inside of the station, strong and pleasing to contemplate.

Nine large windows on the north side in the main wall, 4 more on the west side and still 4 more on the south side, furnish plenty of light, to say nothing of the monitor over the center of the room with its tilting windows for light and ventilation.

require it. Provision has been made for still a fourth unit between the door and No. 3, of either 1000 or 1500 kw. capacity, and this will probably be added before long.

On the south side of the building, equidistant from each end, is located the switchboard on a platform raised about 3 ft. above the main floor. This is of gray marble and consists of 14 panels of which No. 1 contains the exciter switches and ammeters, No. 2 power factor meter, ground detector and Tirrel type T-A-60

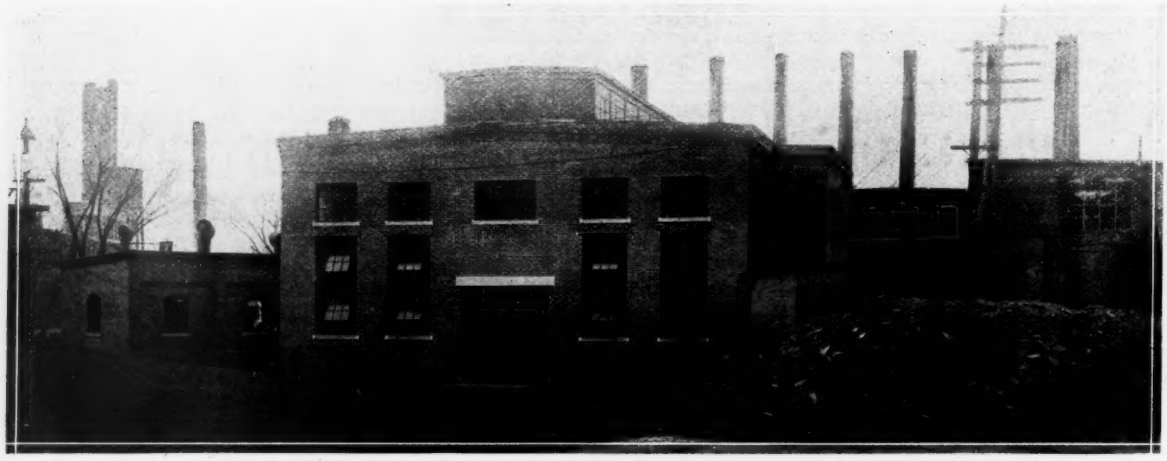


FIG. 2. APPROACH TO MAIN ENTRANCE OF NO. ADAMS GAS LIGHT CO. PLANT

When one first enters the door, he will see what is called No. 3, a 1000-kw. Allis-Chalmers-Parsons single flow, multistage turbine, which is at present the main unit, and drives an Allis-Chalmers a.c. generator of 251 amp. capacity at 2300 volts, 3 phase, 60 cycles, running 3600 r.p.m. Directly beyond this will be seen what we call the twins. These are also Allis-Chalmers-Parsons turbines of 500-kw. capacity and slightly different construction on the steam end, but with generators of the same make and type but only 126 amp. rated capacity each. This makes it possible to run either one or all of the turbines in parallel should the load

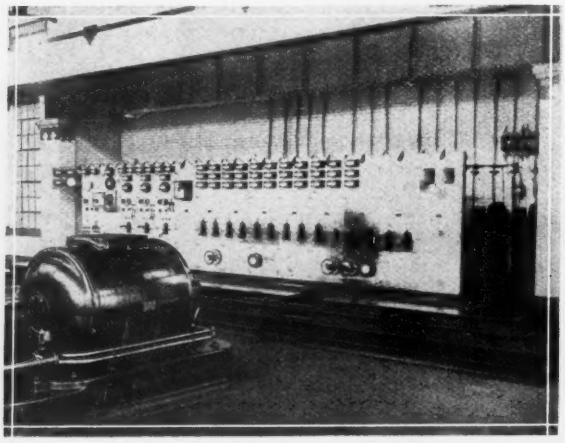


FIG. 3. VIEW OF SWITCHBOARD SHOWING TIRREL REGULATOR AT LEFT AND HIGH-TENSION VOLTAGE REGULATORS TO THE RIGHT AT REAR

voltage regulator. On Nos. 3, 4 and 5 are mounted the main switches, ammeters and wattmeters respectively of Nos. 1, 2 and 3 generators, also their respective field switches. On panel No. 6 is mounted at present a Westinghouse graphic wattmeter, but this panel was intended for the fourth generator panel. Panels 7 to 13, inclusive, are feeder panels, each containing 2 oil circuit breakers of 1000 kw. capacity, while at the extreme right is panel No. 14 with its 2 contact-making voltmeters.

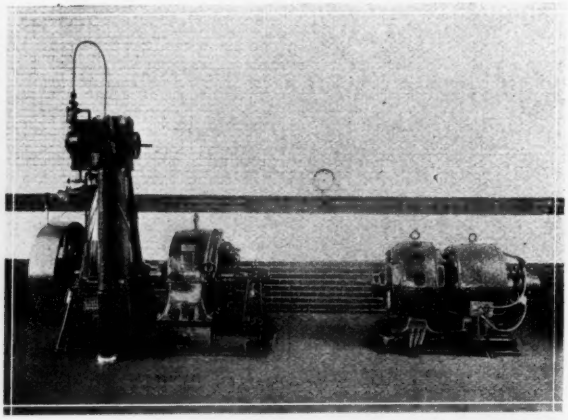


FIG. 4. EXCITER UNITS

In the extreme southeast corner is situated the main exciter unit, which consists of a 120-volt d.c. dynamo of 187½ amp. capacity, driven by a direct connected 3-phase, 2300-volt induction motor of 33⅓ hp., running at 850 r.p.m., and close by is an emergency

exciter consisting of a 120-volt d.c. dynamo of 206 amp. capacity, driven by a direct connected Shepherd automatic vertical engine, 8 by 10 in., running at 365 r.p.m.

On the north side of the station between Nos. 2 and 3 turbines is a 550-volt direct current generator driven by a 200-hp. induction motor. This last is to furnish direct current to a few small factories and will soon be displaced or removed as these factories are installing up-to-date motors. A 10-ton Northern traveling crane completes the equipment of the main floor. All piping is below the floor, except a few feet absolutely necessary to connect the turbines and steam exciter.

In the Basement

BETWEEN Nos. 2 and 3 generators, a stairway leads to the basement, where we find the condensers, feed pumps, heater and service pump. Also the arc light transformers and rectifier tube tanks and switchboards. There are 7 of these latter for as many different circuits and 12 mercury arc rectifier tube tanks. Here also are found the oil-cooled step-up transformers which boost the generated current of 2300 volts to 6600 volts for transmission to the commercial circuits of Adams, Williamstown and the central shaft fan motor of the Hoosac Tunnel, each about 5 mi. from the station. There are 4 of these transformers and a smaller one steps the current down for use around the station and gas plant.

Number 3 condenser is an Allis-Chalmers special siphon condenser for which water is furnished by a double stage rotary pump driven by a 75-hp. induction motor operating on 2300-volt, 3-phase, 60-cycle current. The air is removed from condenser by a double tube water operated ejector.

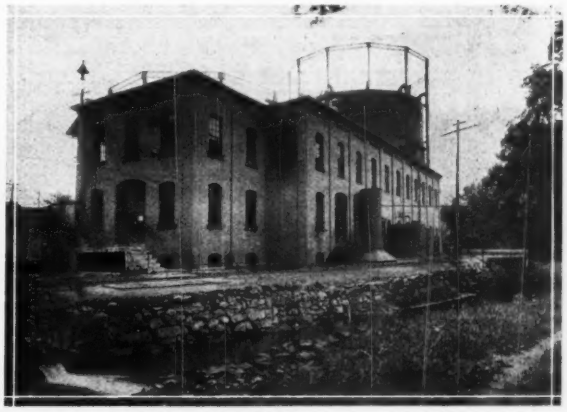


FIG. 7. DISCHARGE PIPE FROM CONDENSERS AND WASTE WATER END OF CANAL. ALL FEED AND CONDENSER WATER TAKEN FROM THIS CANAL. COMPRESSOR HOUSE AND GAS PURIFIER IN BACKGROUND

Condensers of both Nos. 1 and 2 units are also of Allis-Chalmers design, but of a different type from No. 3. The water is supplied by large double gear

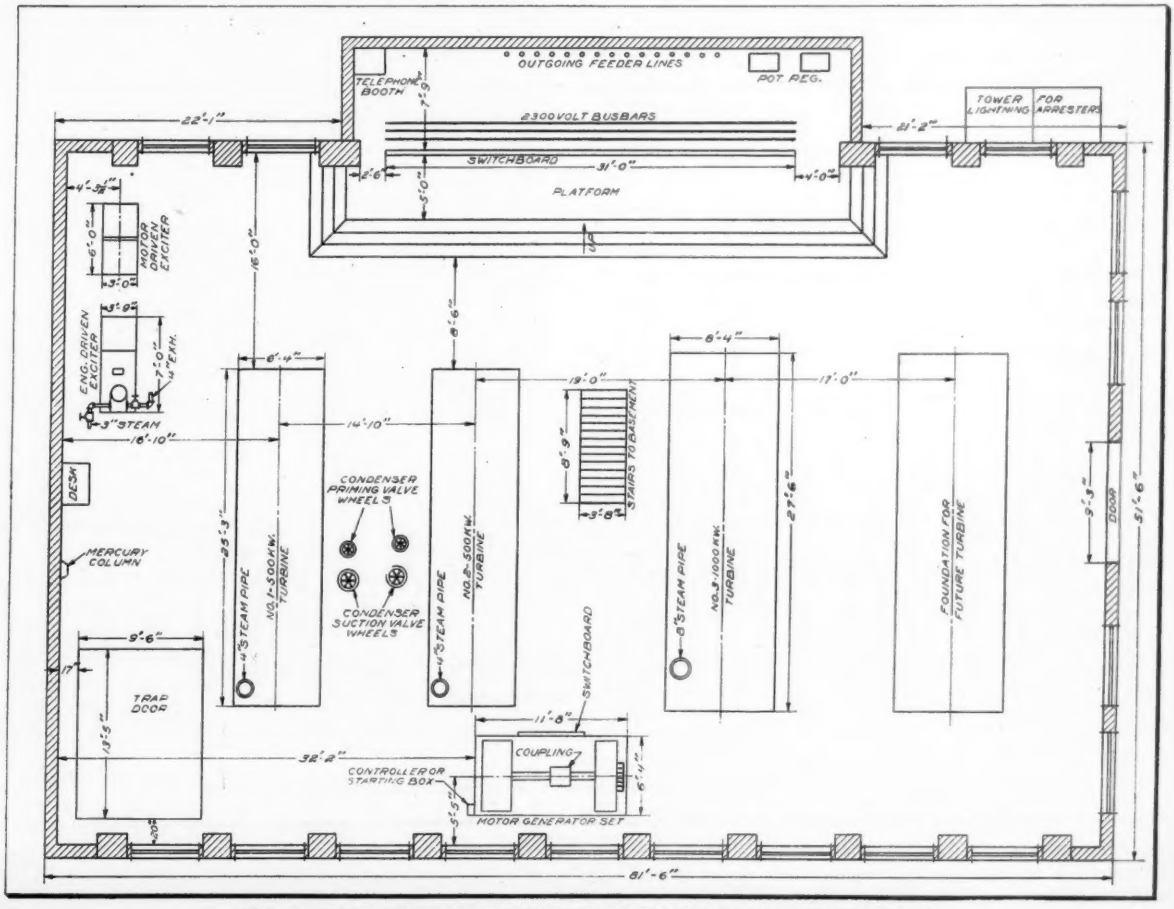


FIG. 5. PLAN OF TURBINE ROOM IN NO. ADAMS GAS LIGHT CO. PLANT

pumps, each driven by an 8 by 10-in. Lycoming engine which is direct-connected, self-oiling, with piston valve and throttling governor. These pumps are built

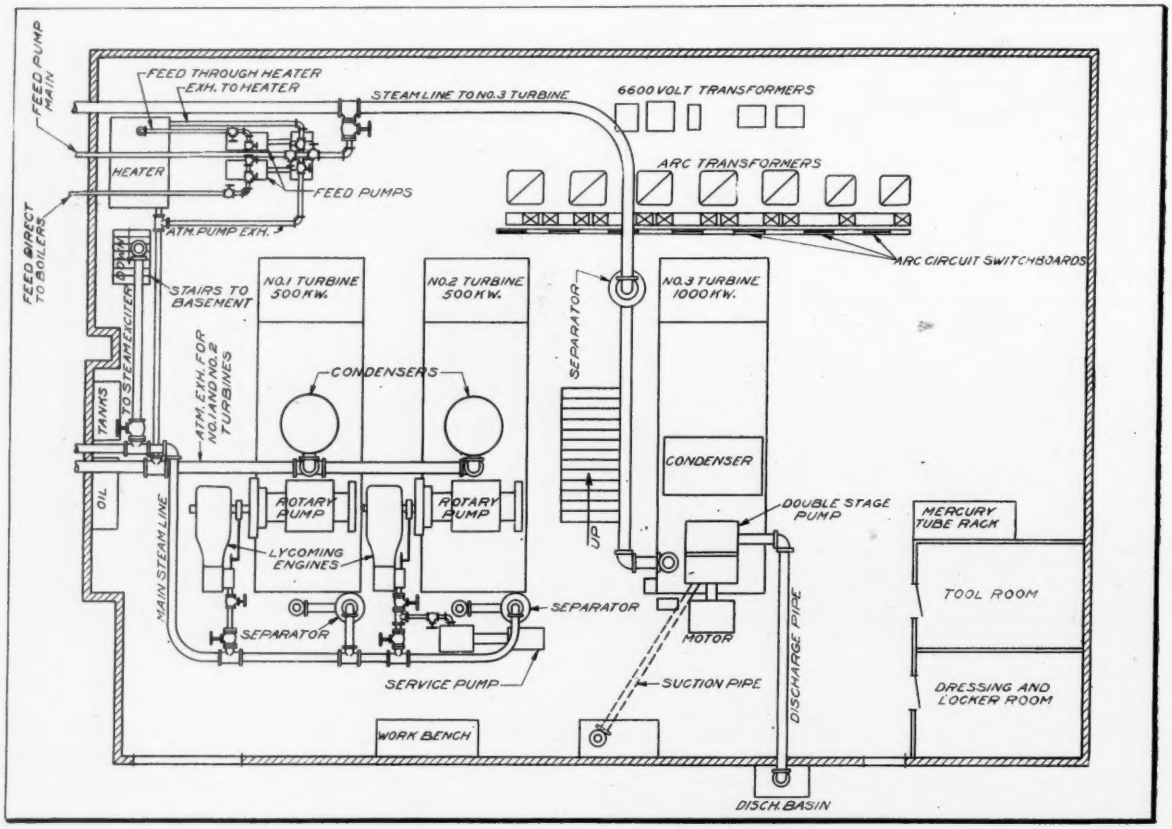


FIG. 6. PLAN OF BASEMENT DIRECTLY BENEATH TURBINE ROOM

by Connersville Blower Co., Connersville, Ind., and have a displacement of 13.4 gal. per revolution. They run at 80 to 100 r.p.m. Water for condensers is taken from the Hoosac River, a dam about 100 yd. west of the station furnishing the reserve supply, which is let in through a canal to a suction basin beneath the basement floor. After passing through the condensers, part of the discharge goes to a hot well near the feed pumps, the remainder is discharged into a pit of concrete just outside the station walls, and from there flows through a 24-in. tile pipe to the canal again, and then back to the river.

In the southeast corner of the basement is situated a compressed air receiver, used for cleaning generators,

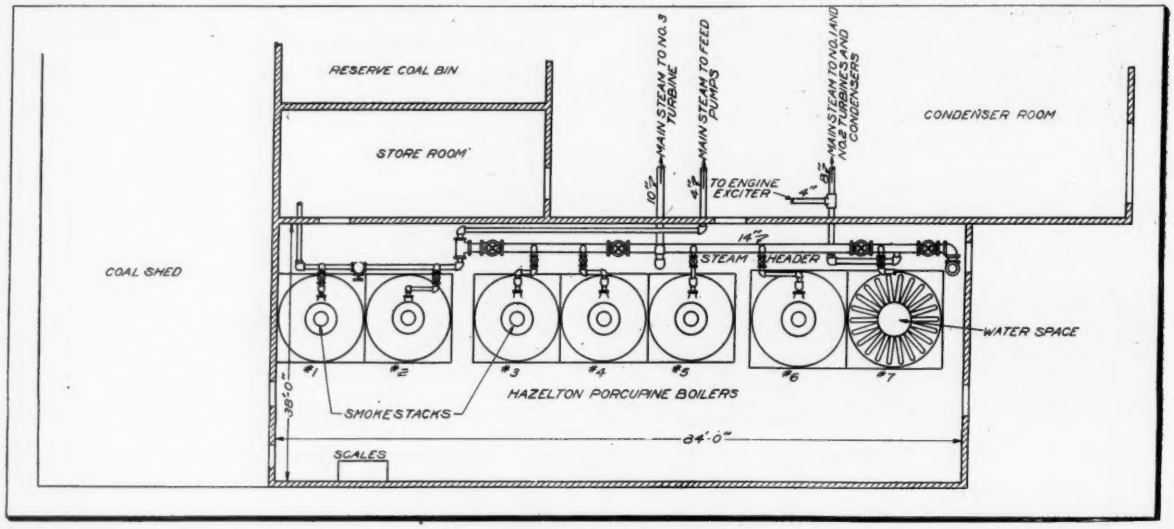


FIG. 8. PLAN OF BOILER ROOM

etc. Near it is a large closed feed-water heater; to the west of this heater are located the 2 boiler feed pumps, one of which is a Worthington duplex 12 by 7½ by 10 in.

the other one is a Deane duplex 12 by 7 by 10 in. These pumps take water from the hot well at 90 to 110 deg. and deliver it to the boilers at from 190 to 220 deg. F. A single Deane service pump, size 12 by 7 by 10 in., completes the equipment of the station. This latter is to furnish cooling water and seal water for the turbines and wash water for the station.

Steam Generators

STEAM for this plant, also the gas plant, is generated in 7 Hazelton water-tube boilers (commonly known as porcupine). Two of these boilers have shells 28 ft. 6 in. long and 42½ in. in diameter, with 918 radial tubes, each 2 ft. 9½ in. long and 4 in. diameter. Three have shells 33 ft. long and 38 in. diameter with 1112 radial tubes 2 ft. 6 in. long and 4 in. diameter. The remaining 2 boilers have shells 28 ft. long, 38½ in. in diameter, 1029 tubes 2 ft. 6 in. by 4 in.

Boilers are hand fired and each discharges into a separate smokestack and natural draft is depended upon which is controlled by a Spencer damper regulator working on a shaft to which boiler dampers are connected as required. During summer 3 boilers are kept in operation while in winter 5 are used.

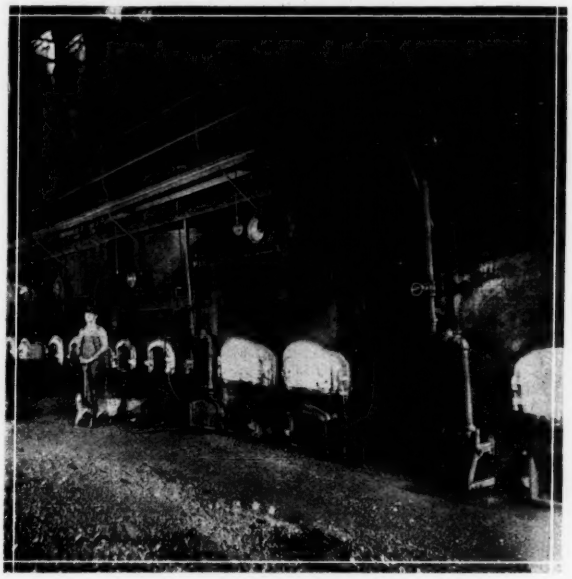


FIG. 9. VIEW IN BOILER ROOM

All boilers are insured for 125 lb. gage pressure, and have proved very efficient. The average evaporation, shown by various tests, is about 10 lb. of water per pound of coal, with 40 to 60 deg. superheat.

Piping System

THIS concludes the list of apparatus except the 14-in. main steam header which extends the whole length of the boiler room and boilers are connected to it by an 8-in. pipe, details of which are shown in the illustration.

Number 3 turbine has a separate steam pipe 8 in. in diameter, leading from header to a separator, then on to turbine. Nos. 1 and 2 turbines with their individual condenser engines, also the service pump, take steam from a second 8-in. main with a separator for each turbine. Each separator has a Squires emergency trap to take care of condensation. The main header also has a trap for the same purpose. The boiler feed pumps have a separate steam pipe and are also connected into No. 3's line. All drips go to the hot well. Atmospheric exhaust of turbines goes free, but exhause of all auxiliaries is piped through the feed-water heater.

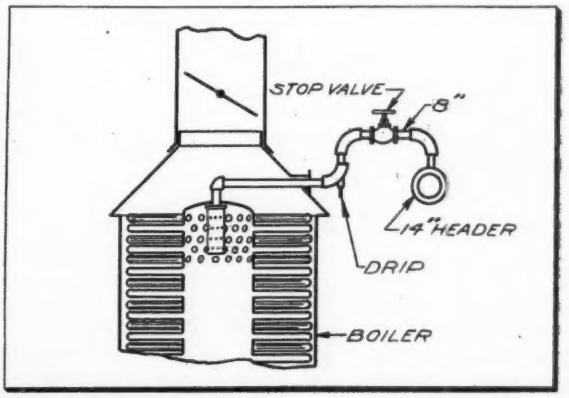


FIG. 10. TYPICAL METHOD OF CONNECTING BOILER TO HEADER

Coal is shoveled direct from cars into coal bunkers of about 2000 tons capacity, and wheeled by man power to the front of the boilers, first being weighed on platform scales.

Daily output of current is 14,000 kw.-hr. in summer and 19,000 kw.-hr. in winter. Coal required per kw.-hr. is 2.5 to 3 lb. for the electric end of the plant. The vacuum carried is 27.5 in. in summer to 29 in fall and winter, average power factor 73 per cent. Coal bunkers run east and west parallel with the station between boilers and railroad track. Boilers are north and south, east of turbine room.

This plant has been in operation nearly 3 yr. with good results. In daytime it furnishes power for several mills and factories in North Adams, Adams, Williamstown and Clarksburg. It also furnishes power to run the huge fans which draw the smoke from the Hoosac Tunnel, and the B. & M. R. R. signals are also operated on current from this station. At night the streets of Williamstown, No. Adams, Adams and Clarksburg are lighted from the same station.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for assistant petroleum chemist. From the register of eligibles certification will be made to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field (at San Francisco, Cal., or Pittsburgh, Pa.), at a salary ranging from $1800 to $2160 a year, and vacancies as they may occur in positions requiring similar qualifications. An educational training equivalent to that required for graduation from a college or university of recognized standing is a prerequisite. The applicant should have demonstrated ability to record and report observations through manuscript reports or published papers. Applicants must have reached their 25th but not their 35th birthday on the date of the examination. Persons who desire this examination should apply for Form 304 and special form to the United States Civil Service Commission, Washington, D. C.; the secretary of the board of examiners, post office, Atlanta, Ga., Chicago, Ill., San Francisco, Cal.; customhouse, New Orleans, La., Honolulu, Hawaii; or to the chairman of the Porto Rican Civil Service Commission, San Juan, P. R. In applying for this examination the title "Assistant Petroleum Chemist (Male)" should be used.

OVERHAULING AN ENGINE

Difficulties with an Old Style Corliss and How They Were Overcome

By Receiver

IT had been in service since 1878, so that modern design to give convenience in adjustment was not to be expected. Nor were there any happy disappointments in this respect. Nevertheless she was overhauled, and when we got through, she was a very presentable job. She was 16 by 42 in., with crab-claw valve gear and alligator crosshead and some other menagerie features.

Poor Type of Crosshead

THIS style of crosshead is shown in Fig. 1, and has the wristpin overhung, the only support being by a bolt in the center, top and bottom, which permits a constant rocking motion, whether visible or not, and has resulted in many a wreck, the crosshead often breaking as shown in Fig. 2, at one place or the other. The best remedy for such a design is a new crosshead, which was decided on in our case as the engine had had little repair since installation, was heavily overloaded and had been running under.

vision was made for inserting pins to prevent the rings springing into the ports when removing the piston, so we secured strips of sheet metal 1 by 10 in. and placed them in the counterbore at 6 points around the cylinder.

For reference in reassembling, prick punch marks were made on piston rod, old crosshead and nut and the distances between these transferred to the engine frame with dividers, prick punched and marked for future reference. The crank was turned to the head end dead center, the nut run back to the end of the thread, and further application of the wrench unscrewed the piston rod from the crosshead without marring the rod. When the rings had slid out on the sheet metal strips, the whole was removed from the cylinder.

As examination showed the cylinder in good condition and but little out of round, and it was expected to replace the engine soon with a larger one, reboring was not thought necessary, and the small shoulders at

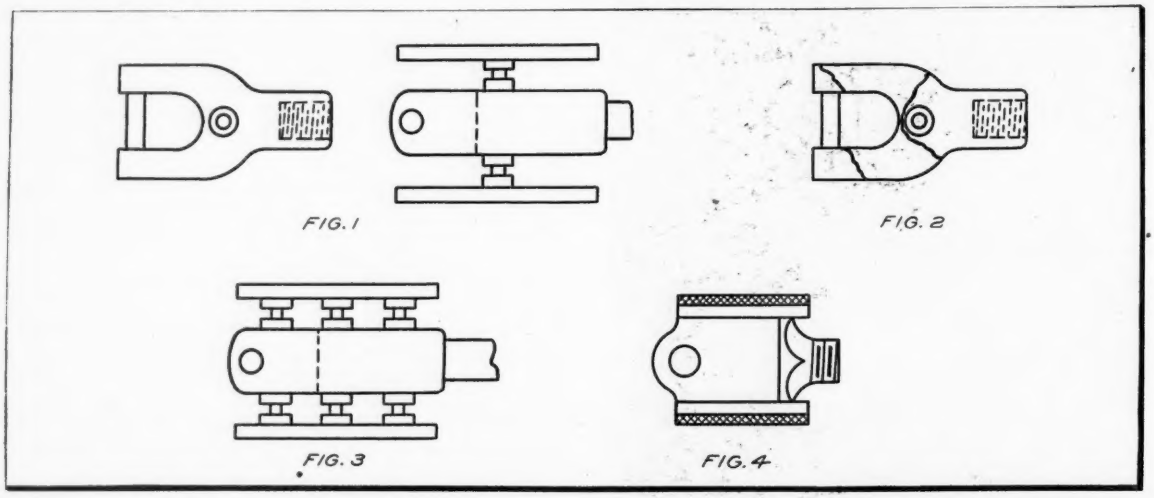


FIG. 1. CONSTRUCTION OF ALLIGATOR CROSSHEAD
FIG. 2. POINTS AT WHICH ALLIGATOR FORM FREQUENTLY BREAKS
FIG. 3. METHOD OF STRENGTHENING CROSSHEAD
FIG. 4. FORM OF MOGUL CROSSHEAD

For such a head, if it cannot be replaced there is an advantage in supporting the pin by bolts as shown in Fig. 3, thus steadying the head against the slippers at both ends. If the head is to be replaced and the modern box type cannot be used on account of the room required for a gib and key strap-end connecting rod, a type called the mogul, as in Fig. 4, is much better than the alligator, and can nearly always be used.

When getting a new crosshead from the shop, it is well to secure the loan of a tap of the same diameter and thread, as the piston rod end, so that the hole in the crosshead may be chased out in case the parts do not fit perfectly.

Removing the Piston

IN our engine, the piston had 2 snap rings similar to the St. Johns steam packing. They were triangular in section, the idea being that the steam would get on the bevel side between the ring and piston and thus force the ring out against the cylinder wall. No pro-

each end were dressed off with file, scraper and finally oilstone. Sharp edges found on each side of each ring, which would tend to scrape oil from the cylinder walls and possibly to cut the cylinder were carefully removed and the rings given rounded edges.

In disconnecting the connecting rod from the crankpin, one of the boxes was found broken. Using the old brass box as a pattern, a new cast-iron box was secured which, as it was babbited, served as well as a brass box and was much cheaper.

Steadying the Guides

TO support the end of the guides, which were formerly unsupported, a pattern and casting were made similar to a screw jack; a heavy stone was set in the cellar bottom, and a piece of 6-in. pipe provided with a flange at each end served as a column to support the jack from the stone. This gave a rigid support to the guides, and allowed for adjustment to compensate for any settling or distortion.

Reassembling

AFTER stretching a center line and lining up the engine, the crosshead was placed in the guides, the connecting rod keyed solid on the wristpin, and the other end brought to rest on the crankpin as it was turned to the 4 quarters. The wristpin boxes were refitted until the crankpin end rested central on that pin at all 4 positions as shown by measurement from center of rod to crankpin shoulders and collar. Fitting of crankpin boxes was accomplished by the reverse method, keying fast to crankpin and measuring for central position of wristpin end in crosshead.

Giving the cylinder a liberal application of oil and putting the sheet iron strips into the counterbore, the piston was replaced in the cylinder, and a piece of 3 by 3-in. spruce was bolted across the cylinder end by means of the studs to serve as a pry for a bar which was worked in the holes into which the follower bolts were countersunk to screw the piston rod into the crosshead. This was screwed up until the marks on rod and crosshead were in correct relation as shown by the reference distance before established.

To get clearance correctly adjusted so that rings would not get caught in the counterbore or ports, the crank was placed on dead center and a pencil mark made on the guide opposite one end of the crosshead.

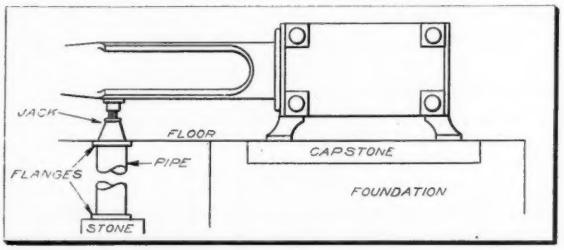


FIG. 5. IMPROVISED SUPPORT FOR GUIDES

The crank was then turned to the other center and the position of the same end of the crosshead marked on the guide, the distance between the 2 marks showing the length of the stroke. The distance that the back cylinder head set into the cylinder was carefully measured, and as the cylinder was piped for indicator, measurement from the joint of the front head and from the inside of the front head to the indicator nipple showed that the front head had practically the same inset as the back head.

A light stick 1 by 3 in. with all surfaces planed straight was cut of length equal to the distance between the front cylinder head and back end of cylinder, and a mark made at a distance from one end of the stick equal to the length of the piston. The stick was secured to the side of the cylinder in position to show the distance from the front cylinder head to back cylinder end, this mark giving the piston position when striking the front head. From this mark, the length of stroke, as found on the guides was laid off, and from the other end the inset of the back cylinder head. The distance between the last 2 marks gave the clearance for both ends of the cylinder as seen in Fig. 6. This proved to be 7/8 in. The advantage of this method is that it avoids possibility of error in addition and subtraction and gives a clear idea of the distances and their relations.

Half the clearance so found, or 7/16 in., was to go to each end of the cylinder, and the piston rod was adjusted in the crosshead by screwing or unscrewing with the crank on head end center until measurement showed a distance from cylinder end to piston equal to the back head inset + 7/16 in., as indicated on Fig. 6. The nut was tightened against the crosshead, the cylinder well oiled and the back head put on and bolted, care being taken to tighten opposite bolts in rotation so as not to strain the studs while tightening and to draw the flange up evenly all around.

Renovating the Valve Gear

EXAMINATION of valve gear and governor showed excessive wear, so the valves were provided with bonnets as shown in Fig. 7, having metallic packing at A so that no soft packing was required. Bushings were bored out and sleeves forced on the valve stems

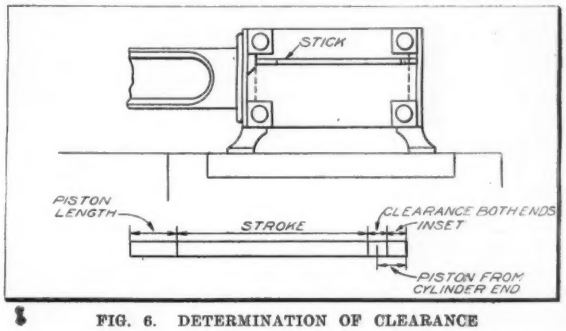


FIG. 6. DETERMINATION OF CLEARANCE

as at B and turned to a good running fit. For dash pot rods and other non-adjustable connections where there was too much play, the holes were reamed out true, and new studs made to fit the larger holes. On the crab claw, the hook block was originally made solid with the stud that held it to the arm, so that only 2 wearing edges were available; new blocks and separate studs were made, giving 4 wearing edges, and quicker adjustment.

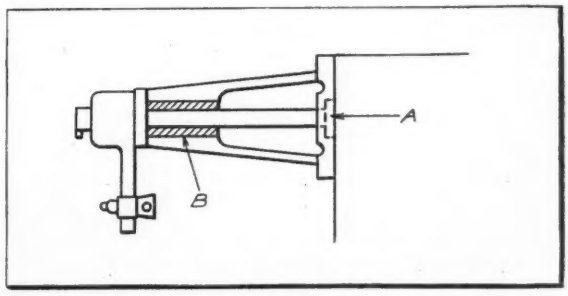


FIG. 7. VALVE BONNET REPAIR

As the wristplate stud which had a tapered fit in the wristplate was badly worn, it was put in a lathe and turned true, and the plate was bored out and babbited to fit, and after going over all joints and bearings to make sure that they were true and ran free, the valves were set by the usual method, the engine started and final adjustments made by use of the indicator. The engine was found to run much steadier than before and with less steam, and seemed grateful for her rejuvenation.

FOR THE INLET and outlet ports of combustion engines, a simple rule is as follows: Make the diameter of the inlet port 0.316 times the diameter of the cylinder, and the diameter of the exhaust port 0.35 times that of the cylinder. If a square or oblong port is to be used, the area of the inlet port should be 1/10 that of the cylinder and for the outlet port 3/25 that of the cylinder.

POINTERS ON BELT AND ROPE TRANSMISSION

With Approximate Cost of Installing Belt and Rope Drives

By Richard Howarth

ADVANTAGE of belting over rope driving is due to its extreme flexibility, it can easily be used on a fast and loose pulley as for instance, on the lathes where it is necessary to change the speed of the machine for nearly every job that comes in. To use rope in a case like this would necessitate the use of gear boxes similar to the automobile to obtain the different speeds required. All pulleys must be in perfect alinement and must be kept so to prevent trouble. Take the case of a small generator with a pulley about 8 in. diameter, it would be practically impossible to drive with ropes to give any satisfaction; on account of the small diameter of the generator pulley, the ropes would have very short life with so small a bend which would cause the inside fibers of the rope to break up through the friction between the inside and outside fibers.

In transmitting a certain amount of power, for example take an engine developing 1000 hp., it requires considerably less width at rim with ropes than with belt. For a belt a rim 110 in. wide would be necessary and with rope drive 60 in. wide 20 ft. diameter using 24 1¾-in. ropes of best hemp. The approximate cost of such a driving wheel is about $3500 and approximate cost of a driving pulley for belt is about $3000, which shows a saving of $500 on cost of wheels by the belt system of drive. The approximate cost of a 2-ply leather belt for this drive is about $2114, approximate cost for 24 1¾-in. ropes is about $700 which shows the approximate amount of saving on ropes over belts for driving. Cost of belt and pulley is $5114, cost of ropes and pulley $4200, a total saving of about $914 by the rope system.

One of the greatest drawbacks of belts is the amount of slip caused by the air cushion between the belt and pulley face, which is a serious factor to contend with, also the electrical disturbances which almost all belts produce is a great trouble in textile mills on account of causing the fibers of the cotton or woolen, as the case may be, to repel each other, making it difficult to produce a smooth yarn. There is at present time an apparatus on the market to neutralize this charge of static electricity, but it is difficult to maintain and is not in very great demand.

Leather belts of the link form have far less amount of slip on account of the air being able to escape between the links of the belt. This is a good style of belt, easy to join together or shorten, but is very costly.

The coefficient of friction between ordinary leather belting and cast-iron pulleys is 0.423. Ultimate strength of ordinary leather belting is 3500 lb. per square inch. The strongest part of a belt has been found by test to be about one-third of the thickness from the flesh side, and in some of the best works in this country the hair side of the belt is run next to the pulley, which increases the capability for transmission of power; the diameters of the pulleys are increased, retaining the same ratio, the increase of power being obtained by the increased velocity.

When the arc of contact is 180 deg. the force that can be transmitted may be taken as 50 lb. per inch of width for single-ply and for double-ply 70 lb. per inch. If more or less than half the circumference be embraced by the belt the force transmitted may be increased or reduced by approximately 2.8 lb. for each 10 deg. of difference from 180 deg. Of course no hard and fast rule can be adopted as the position, condition, speed and other factors affect the drive. A smooth pulley gives the best adhesion and a greasy belt has approximately only ⅓ of the adhesion of a clean belt.

The maximum angle of a main driving belt should not exceed 45 deg. to obtain good results. And pulleys should be allowed ⅛ in. per foot of width for convexity and the pulley made ½ in. wider than the belt. The proportion between the diameters of 2 pulleys working together should not exceed 6 to 1. It must be understood that the working strength of the belt must be taken as that of its weakest part which is the joint. Strength of various joints is shown in the accompanying table:

Leather Belts

Kind of Joint	Average strength in lb. per square inch	Per cent of belt strength
Cemented	2.254	52.12
Laced with rawhide	2.404	59.4
Waxed thread without rivets	3.240	78.4

As is shown in the table, belts which are sewed with waxed thread are strongest, cemented joints are the weakest but it is the best for driving generators as a laced belt is liable to cause heavy vibration and flickering of the lights, sparking and other troubles. The following rule gives good results for single-ply belts: Effective horsepower transmitted = velocity of belt in feet per minute times width in inches of single belt, divided by 470.

Double-ply belts are not recommended to be used over pulleys less than 3 ft. in diameter and a good rule for the double-ply belts is as follows: Horsepower of single belt times 1.5. Another rule: 3 times the width times revolution per minute times diameter of pulley in feet, divided by 625 for single belts, or by 425 for double-ply belts.

To calculate the width necessary for a large double-ply belt: Width of belt in inches = 66,000 times the velocity in feet per second times length in inches of arc of contact on lesser pulley.

With half crossed or twist belts, when the planes of the shafts meet at right angles, the distance apart of the shafts should be at least 5 times the diameter of the pulleys and 20 times the width of the belt if full power is to be transmitted. With a velocity of 1800 ft. per minute a stress of 50 lb. per inch of width of belt may be transmitted. For this class of driving all pulleys should be flat faced and the faces should be lined, not the center lines of the shafts. A rule for calculating diameter of shafts is to extract the cube root of the horsepower, if they are overhung shafts increase by ¼ the diameter.

The various compounds of rubber and canvas belting now put on the market by various firms should be used when exposed to the weather or fumes from chemicals as it is far superior to leather for this class of work. It is interesting to know that the first rope drive ever installed is still running at the age of 49 yr. and is in the Falls Foundry, Belfast, Ireland. In this drive are 9 ropes on the multiple system. It was designed by James Combe.

OPERATING COST

Comparative Figures Between Isolated Plant and Central Station Service

AS an example of what can be and actually was done in a large building in Kansas City, Mo., the following from the Isolated Plant is valuable:

The owner of this building saved exactly $4160 in a single year by installing his own plant.

The central station started by making a price of 5 cents per kw.-hr. and finally came down to 3 cents. A private plant was installed and after it had been operated successfully for one year, the central station began to figure again, and their final estimate was 2 cents for summer service and 1½ cents for winter service. Their feeder was run in, the plant shut down and after a few months taken out, as it was found to be a losing proposition.

Statement of the first year's operation of the plant follows:

Cost of Power Plant Installation

For erection of part of building occupied by plant, figured at 25c. per cu. ft.	$5,250.00
Engines and generators	4,800.00
Boilers	2,350.00
Boiler settings	796.00
Pumps	152.50
Switchboard	1,860.00
Ice machine and freezing tank	1,400.00
Feed-water heater	255.00
Oil burning system	850.00
Return pump and tank	127.00
Pipe work and installation	2,500.00
Total investment	$20,340.50

Cost of Service if Purchased from Central Station

Light, 123,704 kw. at 3½c	$4,329.64
Power, 31,824 kw. at 3c	954.00
Refrigeration, 1 1/5 tons per day at $2.70 a ton	1,182.00
Ice, 250 lb. per day (313 days only) at 22c	172.15
Lamps	144.00
Salary of engineer to care for elevators, plumbing, steam fitting, laundry, machinery, electric wiring, etc., at $85 per month	1,020.00
Extra help for engineer at $15 per month	180.00
Heater for winter season, 6 months:	
Average live steam per hour 2,069 lb.	
Average live steam per day 49,656 lb.	
Cost per day at 45c. per 1000 lb. $22.34	
Cost per season of 182 days	4,065.88
Water heating for winter season:	
187,500 lb. per day from 50 to 100 deg. F. 9,375,000 heat units per day.	
9,375,000 heat units, condensation of 9705 lb. steam from and at 212 deg. F.	
Cost of 9705 lb. steam at 45c. per 1000 lb. $4.36	
Cost per season of 182 days at $4.46	783.52
Water heating for summer season:	
187,500 lb. per day from 70 to 100 deg. F., 5,765,000 heat units per day.	
5,765,000 heat units per day, condensation of 5967 lb. of steam from and at 212.	
5967 lb. steam costing 45c. per 1000 lb. at $2.68 per day.	
Cost for season, 182 days, at $2.68 per day	487.76
Total cost	$13,318.95

Actual Cost of Heat, Light, Power and Engineer's Services

Labor	$2,360.00
Fuel oil	4,488.00
Water	90.00
Oil, waste and supplies	100.00
Boiler compound	180.00
Insurance	25.00
Lamps	144.00
Total paid out	$7,387.00
Cost, if purchased from central station	$13,318.95
Actual cost	7,387.00
	$5,931.95
Depreciation on equipment	$754.52
Interest on entire investment at 5 per cent	1,017.02
	$1,771.54
Cash paid out	7,387.00
Total (Including depreciation and interest on total investment.)	$9,158.54
Cost, if purchased from central station	$13,318.95
Total, including depreciation and interest	9,158.54
Net saving	$4,160.41

Allowing the final rates quoted by the central station, 2 cents and 1½ cents, and estimating 100,000 kw. used during the winter and 23,704 kw. during the summer, and half the power load, or say 16,000 kw. each, for summer and winter, gives the current cost as $2434 and the net saving is still $2265.

USE OF baffle arches in locomotive fire boxes undoubtedly increases the efficiency of combustion, but considerable care is necessary in keeping the tubes supporting these arches free from scale, if reliable operation is to be secured.

The baffle secures more perfect combustion of the fuel, assisting in the mixing of the products of combustion with the air that is admitted above the fire, and it also acts as a reflector of the radiant heat of the fire into the escaping gases.

On account of the enormously high temperature over the fire, unprotected metal cannot be used for supporting the brick and tile of which the baffle is composed, therefore tubes containing water are employed, curved in the form of an arch and communicating with the water jacket of the fire box so that a continuous circulation of water through them is insured.

As these tubes are directly over the fire and at its hottest point, water is evaporated in them at an enormous rate and, if the water contains any scale forming material, scale is sure to collect in these tubes quicker than in any other part of the boiler. Furthermore, while a thin layer of scale might be tolerated on the flue tubes, the arch tubes must be kept clean, as a thin layer of scale which retards the transmission of heat, is liable to result in overheating of the tubes, causing them to bag, blister and burn out.

For removing scale from these arched tubes a special type of cleaner recently perfected by the Lagonda Mfg. Co., of Springfield, O., has the body or turbine part exceptionally short, and the cutting head connection to it by means of a universal coupling.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

THE SYNCHROSCOPE

Connections, Theory and Operation

By V. E. Johnson

THE diagram Fig. 1 shows the connections of an ordinary synchroscope. There are several different types of plugs and correspondingly different connections, but in essentials they are all the same. You will note that with plugs in place, the synchronizing buses are connected to the corresponding terminals of the potential transformers. This means that when the machines are in phase and have equal voltage, there will be no difference of potential between the terminals of the lamps A, which are usually located just below the dial of the indicator, and are

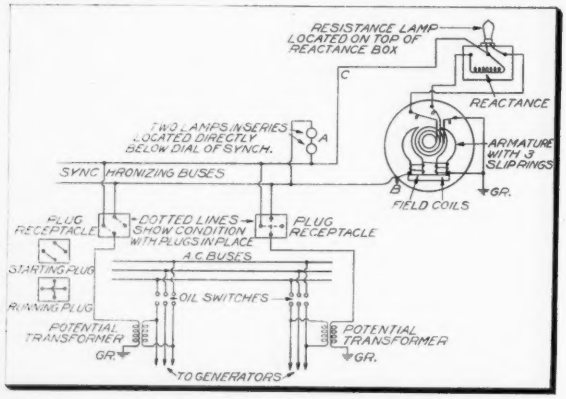


FIG. 1. DIAGRAM OF CONNECTIONS FOR SYNCHROSCOPE

really part of it, although the moving element is independent of them, and will act equally well with the lamps removed. These lamps then perform exactly the same function as the synchronizing lamps. When they are dark, zero potential difference exists between the synchronizing buses, which in turn indicates zero potential across the generator switch, and this we know is the proper condition for closing the switch and paralleling the machines.

The synchroscope consists of a field and armature, and is practically a small motor. The armature has 2 windings at mechanically right angles on the core, and connected to the external circuits by means of 3 slip rings—one of these serving as the common terminal for both coils. In series with one armature winding is connected a noninductive resistance, usually a lamp, and with the other a high inductance, the purpose of these being to cause the current in one armature coil to lag behind that in the other; this lag is so great that, although both windings are in parallel as shown in Fig. 2, the current in one is practically zero when the current in the other is at a maximum, or speaking technically, the current in one lags 90 deg. behind the current in the other.

From the diagram you will note that when plugs are in place, the field of this synchronizing motor is connected across the terminals of the potential transformer of one generator, while the 2-circuit armature is across the terminals of the transformer on the second generator. It is evident that the magnetic relation between the field and armature will decide the location of the pointer. To analyze this more closely, let us suppose for instance that the armature is disconnected. The field sends its flux through the armature, but there is no turning moment, there is no tendency for the armature to assume any particular position, and the pointer will point in any direction. This condition of non-control would be equally true if the armature were to have current flowing through it and the field were left open circuited. Now let us assume the field to be excited and only one armature circuit to be connected—say the armature receives current only through the noninductive circuit, i.e., through the lamp which is ordinarily mounted on the reactance box. If we had direct current flowing through both field and armature, it is readily seen that the armature lines of force would link with the field flux, and the excited coil would assume a position as shown in Fig. 3. The arrow would point up or down—depending on the relative direction of current in the field and armature. If both field and armature were reversed at the same instant, the needle would continue to point in the same direction.

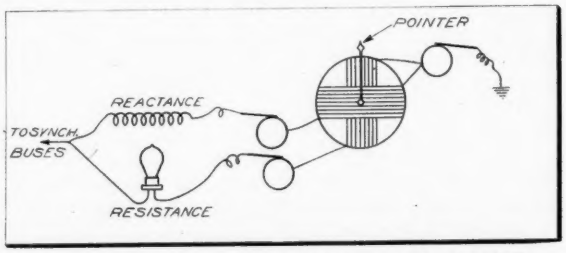


FIG. 2. ARMATURE WINDING OF A SYNCHROSCOPE

So we can apply our illustration to a case where alternating current is used. If the current in both field and armature reverse at the same instant, i.e., if field and armature are in phase, or in opposition, the needle points in a fixed direction, either up or down, as shown by the solid and dotted arrows. That is, if the pointer were pointing up (i.e., in phase) and we were to reverse the connections of either the field or armature, it would indicate "in opposition."

Now let us assume that the 2 generators are in such phase relation that though the speeds are exactly equal, the voltage in one is zero while the voltage

in the other is at a maximum. We now have what is technically known as a phase displacement of 90 deg. between the 2 generators. This is the condition first spoken of; the field and armature are successively excited, but as they do not at any time receive current simultaneously, the armature is free to swing in any direction. So, if we tried to synchronize with one coil of the armature dead, and current flowing only in the noninductive circuit, we would have rather an exciting time. When the 2 machines were in step or in opposition or nearly so, the pointer would indicate up or down, but as soon as the generators became in the neighborhood of 90 or 270 deg. out of phase, the pointer would "wabble" in all directions. In order to get around this difficulty, the second armature coil is used, the current in which is 90 deg. displaced from the current in the noninductive coil.

Now let us suppose that the lamp is unscrewed from its socket, opening the noninductive circuit and leaving only the inductive coil active. The conditions would be analogous to those previously discussed, only that now, in order that the field and armature may have current at the same time, it is necessary for the generators to be approximately 90 or 270 deg. out of phase. Suppose the field to be connected to B generator and the armature to A. When A is 90 deg. ahead of B, the current in the inductive circuit is in phase

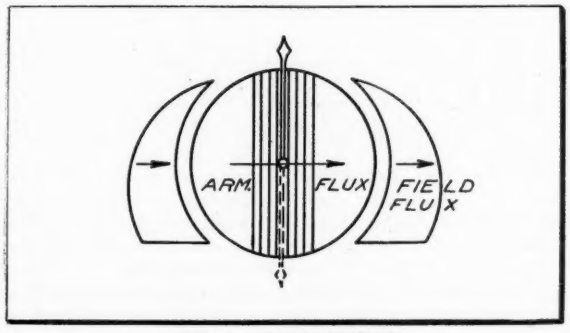


FIG. 3. FLUX DIAGRAM

with the field, for it is 90 deg. behind A. The pointer would indicate either to the left or right depending on whether B or A were ahead. When A and B are in phase, the current in the armature coil is 90 deg. out of phase with the field, and we have the old condition, field and armature successively excited; but at no time are they excited simultaneously and the armature is under no control.

Now let us assume that both coils are connected. When A and B are in step, the armature is controlled by the nonreactive coil and causes the pointer to indicate up. When A and B are 90 deg. out, the noninductive coil is inactive and the inductive coil causes the pointer to assume a fixed position, say to the right. When A and B are in opposition, we have the noninductive coil again in control but in an opposite sense from the first condition and the pointer indicates down. Finally when A and B are 270 deg. out the inductive coil causes the pointer to indicate to the left. At intermediate points, both coils act in proportion to their phase relation with the field, so that the synchroscope indicates in mechanical degrees or in geometrical degrees, the relation in electrical degrees between the generators. When the 2 machines are running at different speeds, this relation is continuously changing, and the pointer continually revolves, indicating "fast" or "slow."

Having learned to synchronize with lamps, one may know that he is, as we say, "phased out" correctly. In order to be sure that you have the synchroscope pointer in the right position, synchronize as you have been doing, and after you have the machines together, put in synchronizing plugs and loosen the set screw on the pointer, turning it to zero. This method is not really scientifically correct, as the machines may have an angular displacement even though they are paralleled, but if machines are running lightly loaded, this will give results close enough for practical purposes. If you, however, wish to be exact, you can disconnect, say, B from the field coils and joint field coil terminals to the other synchronizing bus. This will give you field and armature connected to the same circuit, and this, of course, is exactly in "phase with itself."

After having checked the position of the pointer, its rotation will guide you as to whether the incoming machine is fast or slow, when this has been adjusted, the switch should be closed when the pointer indicates up or in phase. If it is difficult to secure exact similarity in speed, it is permissible to "shoot them on the wing" in which case the switch should be closed just as the machines are approaching synchronism, rather than when they are falling out of step.

SYNCHRONOUS FREQUENCY CHANGERS

Phase Relation Must Be Regulated for Parallel Operation; When to Use Synchronous and When Induction Motor Drive; Single or Double Exciter

MANY operating conditions require the conversion of electrical energy from one frequency to another, which is economically and efficiently accomplished by means of frequency changers. Some of the special features of Westinghouse Electric changer sets are space economy, they are self-starting; stators of both motor and generator are mounted on a common bedplate and as close together as mechanical clearance and ventilation requirements will permit. Both rotating parts are mounted on a common shaft, and where practical, only 2 bearings are supplied. A pedestal bearing is ordinarily mounted on a "bridge," as illustrated. In case of repairs, this bridge can be quickly removed and the stator easily slid to one side along the bedplate, to allow ready access to either stator or rotor.

If conditions require 2 or more synchronous sets to operate in parallel, the rotor of all generators must bear the same phase relationship on their respective shafts. It is not practical to set these rotors with sufficient accuracy during the process of manufacture. One stator is therefore set in a "cradle" which permits of sufficient rotation to obtain a proper alinement, as illustrated. This adjustment has to be made only when starting up the sets for the first time, and thereafter their relative locations do not change.

The stationary frames are rigid iron castings into which soft steel laminations are dovetailed and securely fastened. Ventilating ducts are spaced at frequent intervals across the face of the armature punchings.

A rugged spider is used, to which field poles, built of thin steel laminations riveted together, are either bolted or dovetailed, as required by the speed of the set. These poles have overhung tips provided to sup-

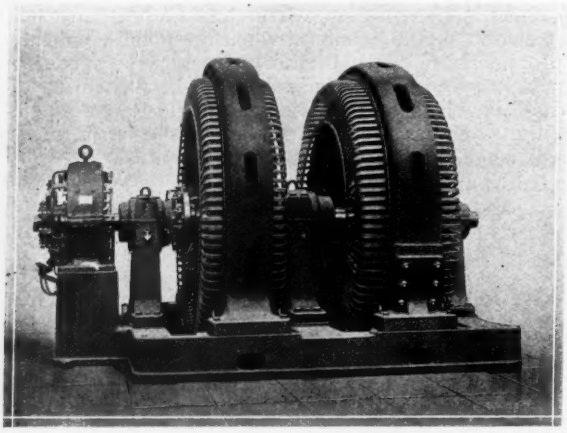
port the field coils which are built up of heavy copper strap wound on edge, and insulated in such a manner that the individual turns are each exposed to the air for ventilation.

Bearings are ring oiling, split horizontally to allow ready removal, and lined with grooved babbit.

In selecting a set it should be considered that a high-speed set is generally somewhat cheaper than a low-speed one, but may not give the exact frequency ratio required.

The synchronous type has certain advantages which render it the almost invariable choice, but there may be cases where an induction set would be preferable.

The synchronous set is slightly more efficient. It permits of operation of the motor at unity power factor, its point of highest efficiency, or by slightly increasing the capacity gives a leading current, thus



COMPLETE FREQUENCY CHANGER SET, SHOWING PEDESTAL, CRADLE FOR GENERATOR, AND PROVISION FOR SLIDING STATORS ENDWISE

obtaining a corrective effort which is often desirable. The synchronous set can at slightly increased expense be made reversible.

The synchronous set is at a disadvantage when of relatively small capacity and required to tie 2 much larger generating systems together. In this case the speed of one system must always have the same relation to the speed of the other system and any change on one must be transmitted through the set and the frequency changer supply the power necessary to bring the speed of the other system to its corresponding value—enabling heavy overloads to be imposed on the set. Here the induction outfit, with some variation in slip possible, may be the proper machine.

A direct-connected exciter can be supplied mounted on either motor or generator end of the set, and of capacity to furnish either motor or generator, or both, with the necessary excitation. When variable loads are likely to be encountered, and an automatic regulator is used, separate exciters for motor and generator are usually preferable, inasmuch as a common exciter would necessitate constant attention in order to control the power factor of the motor.

TELLURIUM IS A METAL which is obtained as a by-product in the smelting of copper but no use is known for it. Geologists claim that a fortune awaits the individual who can find a commercial use for this otherwise valueless mineral.

ELECTRICAL CORRESPONDENCE

SLOTTING COMMUTATOR

MUCH has been said for and against slotting of commutators and descriptions of a great variety of tools and apparatus for slotting have been given in these columns. Many of these tools are complicated, some even requiring motors to drive them. I always read these articles with comparative indifference till one of our generators developed a strange malady several months ago.

At even distances around the commutator a black smudge would collect and when once started, would keep building up till after a few hours' running the lights would flicker so badly that we had to change over to another unit.

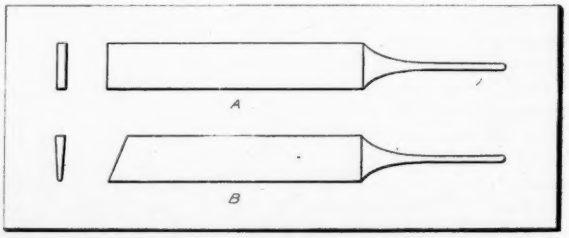


FIG. 1. FORM OF SCRAPER USED FOR UNDERCUTTING MICA IN COMMUTATOR

This black smudge we found, could not be wiped off. Gasoline would not even soften it and we began to sandpaper this commutator regulation style, with one sheet of sandpaper and a perfectly straight piece of wood.

As long as the commutator was perfectly clean there was no flicker showing that it was this coating and not loose connections, etc., that caused our trouble. Sometimes this commutator would stay clean for 3 or 4 days and then coat over inside of from 3 to 6 hr., and other times we had to sandpaper it twice a day.

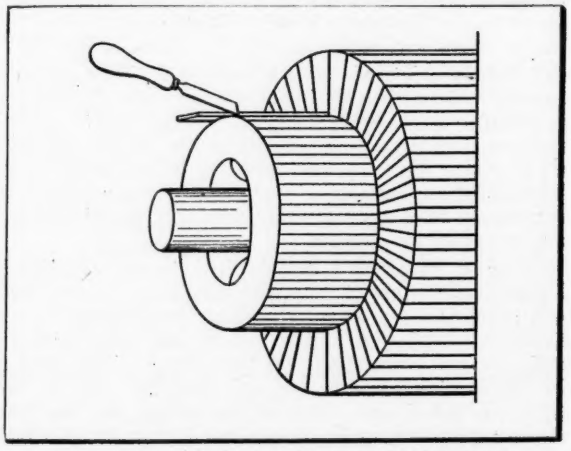


FIG. 2. METHOD OF SLOTTING THE COMMUTATOR

We decided at one time that it was a case of soft brushes and put in a new set without getting different results. We experimented with different tensions on the brushes but all to no avail. Finally I called in an expert; high mica, he said, and recommended a certain stone to be used in place of the sandpaper.

I ordered the stone and as soon as it came we tried it. Well, it worked fine for about a week and then we were back at the old point. Try as we might

we could not overcome this trouble and I called in another expert. Turn down your commutator, this one advised, and I ordered it done at once.

Imagine our surprise when only 2 weeks later symptoms of our old trouble began to show again in company of a new one. We had never had trouble with a rough commutator before and now it was rough and grooved badly.

That was the time I decided to slot my commutator and I want to describe the tool we used and the way we did it.

Among our tools we had a small, flat scraper, ⅛ in. thick by ⅝ in. wide and 3½ in. long. We ground down the end of this scraper till one side of it was only the thickness of the mica between the segments, 1/32 in., and rounded it off. Then we ground back the thick end till it made an angle of about 70 deg., with the lower edge of the scraper. Figure 1, A and B, show scraper before and after grinding. We took a short straight edge, slightly longer than the width of the commutator, placed this parallel with one of the slots and a trifle to one side of it and ran point of scraper lightly over the mica to get the groove started. About the third time across we increased the pressure on the scraper as then the danger of slipping and scratching up the segments was much less. From 6 to 8 passes across made a groove about 1/64 in. deep, which is deep enough for all practical purposes and not deep enough to hold any carbon dust, etc., and cause short-circuiting of the segments.

It took an engineer and an oiler 10 hr. each to do the job complete. The first day less than half of the 432 slots were cut, but we smoothed off the commutator with the stone previously mentioned and used the machine during the night and finished the job the next day.

We have not had a sign of trouble since. Our commutator is as smooth as glass and has taken on this dark brown gloss which we all like to see so much on motor and generator commutators. Figure 2 is intended to give an idea of our method of doing this job and if anyone knows of a more simple and inexpensive way of doing it I should like to hear of it.

Karl H. Muller.

BRUSH TROUBLE

I HAVE in my care a 40-kw., d.c., 220-volt multiple Westinghouse machine; there are 160 segments in the commutator, the brushes are set so that there are 40 segments from the tip of one brush to the tip of next set. One set of brushes heats quite hot. Will you please tell me what causes this heat; the machine is not overloaded and there is no sparking at the commutator? I use graphite and carbon brushes.

A. C.

A. There are several reasons which may cause one set of brushes to heat more than the others.

If you are using graphite and carbon brushes at the same time, this may be the cause of your trouble. The same kind of brushes should be used in studs of same polarity, otherwise the lower resistance brushes will carry excessive load. That, in your case, means that the 2 (+) arms should have, say, the graphite brushes and the 2 (—) arms the carbon brushes.

Another cause of heating as you describe, is unequal brush tension. This may sound rather like a fable, but it is a fact that a difference in spring tension will cause unequal distribution of load, and consequent heating of the more heavily loaded brushes.

Heating is frequently caused by poor contact, some of the brushes not fitting the commutator closely.

Another cause of heating is loose connectors between the arms, so that the load divides unequally due to poor contact. Related to this defect is that of too small cross connectors, causing the arm to which lead is fastened to carry more than its share of current.

V. E. Johnson.

NOISES AT NIGHT

Sharp Reports Cause Gun Play and Bring Police into Actual Work

By Dan Royer

THE watchman had made his 3 o'clock round and settled himself in front of the boilers for a quiet smoke. The night was warm and he nodded in his chair. Suddenly he jumped to his feet. He was sure he heard a shot in the adjoining building, which housed the water-softening plant. He listened intently with every muscle rigid. After a few minutes waiting, he heard 3 reports in the softening plant—first one, then a pause, then 2 in quick succession.

"No cross compound, condensing gun man is going to lay me out, without some resistance on my part," said the watchman to give himself courage as he ran to the office and got the enormous Colt's provided for the defence of the building. When he returned to the boiler room he found everything quiet, but he got behind the door and trained his gun in the direction the shots apparently came from.

He waited what seemd to him to be several hours, but no sound came from the darkness of the softening plant. He took his lantern and gun and made a careful inspection of the softening plant, but could discover nothing suspicious. As he came through the boiler room door, 2 reports suddenly sounded in the darkness. He jumped behind the door and replied with the Colt's. After a few minutes of quiet a policeman came in, and seeing the watchman with his drawn gun, demanded an explanation of the commotion.

"There is someone in there trying to shoot me," fervently declared the watchman, pointing toward the darkness on the other side of the door.

"You are dreaming, man—what the—." "Bang—Bang" from the softening plant, and the cop joined the watchman behind the door, drawing his gun on the jump. Together they blazed away into the darkness. After considerable target practice they looked around carefully but could see nothing wrong, and waited in vain till daylight for some further disturbance.

When the fireman came, the watchman told his story, and was chagrined to see the fireman double up with laughter. When he regained his breath sufficiently he took the watchman back under one of the treating tanks and showed him a barrel that had been placed under a leak in one of the pipes. He explained that the "old man" had come in the previous evening and told him to put a barrel under the leak. The only barrel he could find contained some burned out incandescent lamps, and he failed to empty them out. When the barrel was filled by water from the leak the lamps began to float to the edge, drop over and break on the concrete floor. These reports gave the watchman the impression someone had designs on his life.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Systems of Suspension for Fixing Objects in Concrete Ceilings; Efficacy of Autogenous Soldering for Steam Boiler Repairs

By J. H. Blakey

IT is difficult to fix supports of any kind in structures of re-enforced concrete after the setting of the concrete. It is preferable to arrange previously in the forms, before pouring the concrete, suitable pieces to provide simple means of attachment. Fastening bolts may be set in the forms at intervals, in

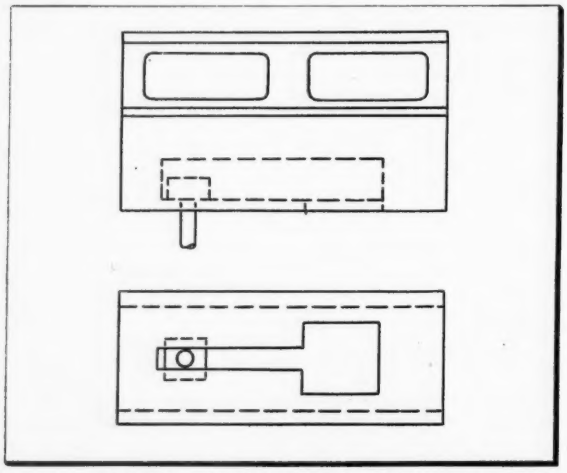


FIG. 1. CAST-IRON BOX TO SUPPORT BOLT IN CONCRETE CEILING

such a way that wooden stringers may be supported, these stringers serving as a means of support for whatever fixtures are to be used. Sometimes instead of the stringer a channel iron may be used.

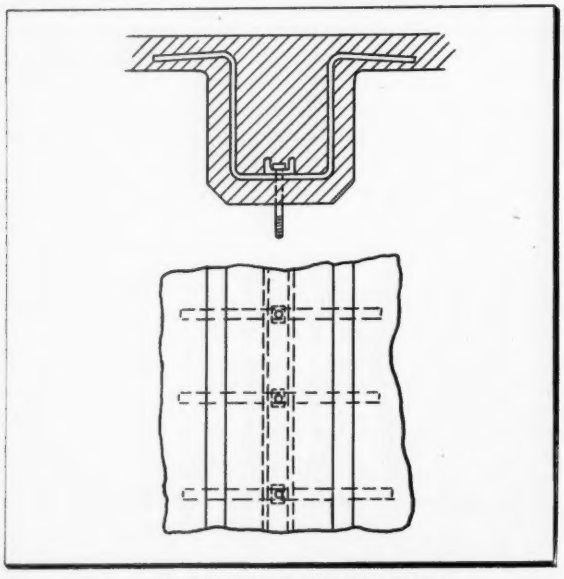


FIG. 2. BOLT HELD BY CHANNEL IRON

Figure 1 represents another system of suspension, which consists of introducing into the form before pouring the concrete, a sort of hollow cast-iron box, having on its lower surface a square opening extended by a prolongation wide enough for the diameter of the bolt. This has the advantage of allowing a certain amount of adjustment in the position of the bolt. Figure 2 shows another system of suspension, which is supported by the metal work of the structure. The channel iron is drilled at intervals, and through each hole passes a bolt. Figure 3 represents a piece of cast iron which is placed in the form before the pouring of the concrete, and which is held on the bottom of the form by the nail shown. The attachment to be suspended is screwed into the threaded hole. This method is used principally for lighting fixtures.—From Il Cemento, Turin.

Autogenous Soldering

IT may be well, at the outset, to define the expression "autogenous soldering." This is the process of uniting pieces of metal by the fusion of their own substance, without the use of a special solder. It is performed by means of the airohydrogen or oxyhydrogen blowpipe, or by electricity.

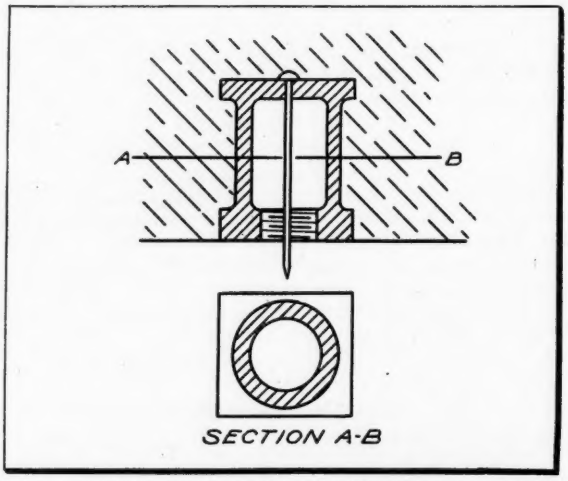


FIG. 3. SUPPORT FOR LIGHTING FIXTURES IN CONCRETE BUILDINGS

The steam boiler furnished by a German manufacturing concern was found to have a fissure some 8 in. in length in the lower part of the firebox, which necessitated repairs in the plant in which it was installed. The owners, having shown that there was insufficient metal at the point of fissure, sought reimbursement from the manufacturers. In the course of the discussion which arose, the manufacturers stated that autogenous soldering was not suitable for such repairs, because the piece of plate put into the opening retained strong tensions in consequence of the irregular heating of the torch, so that the repair would always open again.

The author challenges this assertion, and shows that the success of the soldering in the forge depends upon the skill and knowledge of the workman performing the operation. This method of soldering has been in use for but a short time, and is frequently attempted by persons having an insufficient knowledge of the

nature of steel. The fact that the process is unsuccessful in many cases is no proof that it will always be so in the case of boilers. It is necessary to take into account the possibility of overheating the metal, and the formation of oxides and of stresses, as if these factors are neglected it often happens that the high temperature of the flame burns the steel and gives rise to occlusions of oxides. Some failures in the case of boiler plates, however, due to the incompetence of the workman, should not lead to the abandonment of the process in all boiler repairs. The conditions to be observed are to complete the operation as quickly as may be, to diminish as much as possible the absorption of carbon by the steel, and to avoid the injurious effects of an uneven heating of the metal. The surest means of meeting these conditions is to heat previously the neighboring parts of the plate.

In the case of soldering thick plates of soft steel it is necessary that the adjacent metal should be heated to a dull red for a distance of about 30 in. on each side of the repair, in order that the soldering may be surrounded by metal which will give up heat rather than absorb it. This also quickens the process, without risk of burning the steel.

Sheets which have been submitted to a soldering necessitating the heating of a large area of the surrounding metal, are liable to retain tensions which may result in fissures, and which are therefore dangerous. Recent methods give the possibility of avoiding these tensions, and the following is one which has proved satisfactory:

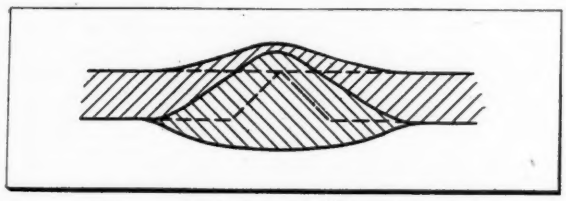


FIG. 4. FORM OF AN AUTOGENOUS WELD

After having made a triangular cut the length of the place to be soldered (Fig. 4, dotted lines), the edges of the plate are heated with the torch; they are then hammered to give them an arched form, from below, until the upper part of the curve has a thickness of not more than 0.2 in. Now the surrounding parts are heated, and a piece of hot metal is laid in, of such a size as to bring the total thickness of the joint to double that of the plate, hammering until cold with a ball pein hammer. The next operation is to heat the surrounding parts of the plate, and to continue hammering the ridge formed by the insertion of the metal. This, it will be seen, subjects the whole heated area to a stress of compression rather than of tension, and the situation is not materially altered by the shrinkage due to cooling. This method avoids injurious changes in the chemical composition of the metal, which sometimes occur as the result of too rapid cooling. The hammering also gives a homogeneous metal which is often stronger than the plate itself. Finally, all danger of overheating the steel is avoided.—From Acetylene in Wissenschaft und Industrie.

WHERE THE TEMPERATURE is apt to fluctuate, it is said to be inadvisable to use cast-iron pipe fittings in lines conveying superheated steam; but where the temperature is maintained at a constant figure, this class of fittings can be used with safety.—Ice.

COMPACT WATER COOLING APPARATUS

Partial Evaporation and Air Cooling Are Principal Features

IN connection with electric power stations, there is frequently a difficulty in arranging for the running of the engines condensing, owing to the fact that a plentiful supply of cooling water may not be immediately available. Where this is the case, means are taken to use a limited quantity of water repeatedly for cooling. In every pound of water evaporated there is the equivalent of 966 deg. F. in latent heat so that for every pound evaporated there is 966 deg. cooling of a pound of water plus the difference between the temperature of the hot water and 212 deg. There is the cooling effect of the air due to the increased rise of temperature, but as the specific heat of air is only a quarter of that of water, it will be seen that 4 lb. of air are required to cool 1 lb. of water to the same number of degrees, so that the proportion of cooling by air is generally less than the amount of cooling done by evaporation. The object sought in mechanical cooling, however, is to get as much cooling efficiency by the rise of temperature of the air so as to reduce the loss by evaporation to as small an amount as possible. With these points in view, therefore, it is interesting to examine a type of cooler which has been developed by Messrs. C. Whittaker & Co., Ltd., of Accrington, England, and which embodies the general principles which are usually found in tower cooling with great compactness.

The cooling effect is obtained by the partial evaporation of the water which is being cooled and by the rise of temperature of the air, and in this mechanical cooler the intimate contact between the air and water which is necessary for this work is obtained by producing a film of water by means of rotors revolving in a bath containing the water to be cooled, this water being gradually filmed on to the surface of the rotors, and as the rotors revolve air is carried over the surfaces. As a rule the design of the cooler is in the form of a cylindrical tank built up in sections, divided into 4 or more compartments, and in each of these compartments a cooler is rotated. In this way fractional cooling is obtained. The compartments vary in size from 3 ft. 6 in. in diameter to 9 ft. 6 in. in diameter, and they present for filming purposes an enormous surface due to the design of the rotor. Each cubic foot of filming surface contains nearly 100 sq. ft. of superficial filming area, hence it will be seen that in a series of rotors 8 or 9 ft. in diameter and 4 or more in number, all the advantages of large surface are obtained in a very small space.

The air current is supplied by mechanical means either by a propeller fan or a centrifugal type of fan. The former is especially valuable where the cooler has to be used outside the building in which the power plant is erected, but where the cooler is fixed inside the basement of a large building, the most suitable type of cooler is the one with the centrifugal fan, which draws the air from the filmers and discharges any moist air into a metallic duct which can convey the vapor to a discharge point outside the building. These coolers are usually driven by a variable speed electric motor and in this way a constant cooling effect is obtained either by increasing or diminishing the speed of the fan according to the variation in the atmospheric

conditions both as regards temperature and humidity. In certain cases, as for example in the cooling of the water for large or small power gas engines, the water can also be circulated by means of a high-speed centrifugal pump.

Quite recently some coolers on this principle have been designed in series to cool from 50,000 to 100,000 gal. of water per hour, and in most cases the loss by evaporation has been found not to exceed 1.5 per cent of the total water dealt with. The machines are designed as to cooling surface and air capacity according to special requirements, but as a rule something like the following figures are found to obtain.

Air Temperature Deg. F.	Humidity Per Cent	Hot Water Deg. F.	Cold Water Deg. F.
70	75	123	88
65	75	119	84
60	75	116	81
55	75	115	80
50	75	114	79
45	75	113	78
40	75	112	77

It will be seen from the above table that these are practically the same results as are got from the best cooling tower systems and it is therefore apparent that an interesting development has been made in this particular sphere of power house practice.

ICE PLANT RENOVATION

Careful Inspection of Machinery Piping and Fittings; Systematic Planning of Material Needed and Work to Be Done; Extra Precautions in Doing All Piping Work as Noted Will Insure Freedom From Operating Trouble

By W. S. Luckenbach

As the season of artificial ice making is nearing its close, it behooves every owner and conscientious engineer to investigate and compare carefully with other plants as to where additions or alterations may be installed in order to increase either capacity or purity, or both, without increasing cost of production. This is comparatively easy provided the engineer enters daily a correct account of consumption of fuel, temperature of liquid ammonia at the expansion valve, temperature of feed and cooling water, also temperature of brine and distilled or raw water. When the production of ice each 24 hr., together with labor, oil and general expenses is included, he will be in fairly good shape to determine along what lines improvements should be made and have the material on hand ready in order to avoid delay. Especially is this necessary where there is only one unit to supply the demand.

It is well for the engineer to go over the entire plant and carefully note all defects; take nothing for granted; do not depend on memory; do not neglect a single nipple or fitting. Then by laying the work out systematically you will be able to do it well and expeditiously.

Should the freezing or brine tank or the expansion coils require attention necessitating the withdrawal of the brine, the work should be done quickly, so that the expansion coils will not be exposed to the atmosphere longer than necessary in order to avoid excessive rust. See, however, that all coils are securely strapped and have a regular incline with no traps in the pipes, and test them to not less than 300 lb. pressure. In making repairs, use nothing but extra heavy pipe and fittings on the ammonia system, and put up no single piece of pipe or nipple until you have seen that there is no internal obstruction such as blisters, etc.

In cutting pipe with the ordinary pipe cutter it frequently happens that the area is less at that point by reason of dull cutters. It is well to look after this for two reasons, first, it decreases the area, and second, the ragged edges are apt to catch any foreign substance and reduce the area still more.

Use no pasty substance in screwing up joints, because it collects between the threads and while it may apparently be screwed tight this pasty matter is simply jammed between the threads and it will be a question of time when the ammonia will penetrate, and a leak result; and that leak may occur when it will not only give the engineer a world of trouble in the busy season but a financial loss as well. In the writer's judgment, the first requisite is good full threads on both pipe and fittings, then with good lubricating oil screwed up good and hard you have a lasting job.

Another matter that does not get the attention it deserves is the installation of thermometers at various places where they will not only save the engineer a lot of trouble and guesswork but be a financial gain. For instance, a thermometer at the expansion valve indicating, say, 10 deg. increased temperature would, by referring to the table of properties of saturated ammonia, show that the expanded gas in the coils would absorb about 10 times less heat, and of course increase the brine temperature to that extent; hence, by having a thermometer at that point; the engineer would not wait until the brine had gone up several points, then guess as to where the trouble was, but would know at once by glancing at the thermometer and apply the remedy, viz.: more or colder cooling water on the condensing coils, or cleaning them.

The same applies to the distilled or raw water for ice; an increase of 5 deg. would mean about one ton less ice on a 50-ton machine per 24 hr. Instances of equal importance will easily suggest themselves; the above is simply cited to impress the average engineer with the importance of looking after small matters that in the aggregate will amount to considerable and will undoubtedly be appreciated by the owner.

In conclusion, be sure to have the liquid ammonia pipe from the condenser run through the coolest part of the building so as to maintain, as nearly as possible, the same temperature as when leaving the condenser. Keep the engine room in good order and clean. Have a place for all tools and a general good order system, because it has a good effect on all the men, and any ice machine men visiting will consequently carry with them a good opinion of the man in charge, which may at some future time be valuable.

AN UP-TO-DATE ICE PLANT

The engine room of the new power plant of the Kentucky Traction & Terminal Co., at Lexington, has an ice plant quite different from those ordinarily met. Two 75-hp. Terry turbines, direct connected to 2 8000-gal. centrifugal water pumps for pumping cooling water from the spray pond for the steam and ammonia condensers, furnish exhaust steam for use in the generator of the Carbondale Machine Co.'s ice plant, located on a platform back of the main generating units.

In this generator ammonia gas is driven off from aqua ammonia and sufficient pressure produced so that the gas after being dried is condensed into anhydrous ammonia, which passes through a 1½-in. pipe line a distance of

more than 500 ft. to the building containing ice tanks, where it is expanded through the coils. The expanded gas from the expansion coils, after passing through the coils in the distilled water storage tanks, returns through a 6-in. line to the absorber on the roof of the power house.

The exhaust from one of the Terry turbines is sufficient for the generator under ordinary circumstances. During the summer months, with condensing water at 95 deg. F., the increased steam consumption due to back pressure on the turbine does not exceed 20 lb. per hour per ton of ice—about ⅓ that required for a compound condensing compression machine. During the winter months the consumption is but 3 lb. per hour per ton of ice.

As the pure condensate from the turbines is entirely free from oil, the ice made from it is of superior quality—an excellent advertising feature. A bacteriological analysis shows it to be almost absolutely sterile. This feature of the exhaust of turbines has been made use of in many ice plants all over the country, in order to get away from the troubles incident to other sources of distilled water. The whole plant was erected under the supervision of Sargent & Lundy, Consulting Engineers, Chicago.

A LOOSE CRANKPIN

Finding Diameter of Crankpin, Improvising Means for Fitting Pin and Shrinking It in Disk

THE engineer who thinks he has his hands full when something goes wrong would hardly appreciate the roadman's job.

Doing considerable of the outside repair work for the company in whose employ I am, it became my lot to go to a mountain sawmill to tighten a crankpin.

As a rule the roadman appreciates all the information he can get pertaining to the job he is detailed to straighten out and all the instruction I received was, to tighten the crankpin.

Having served 7 yr. in a machine shop, including my apprenticeship, where their work was mostly on engines, the matter did not bother me. I could not think of any means to tighten a crankpin satisfactorily unless there were some patent device which would not be common on a large engine, this engine's average load being 200 hp.

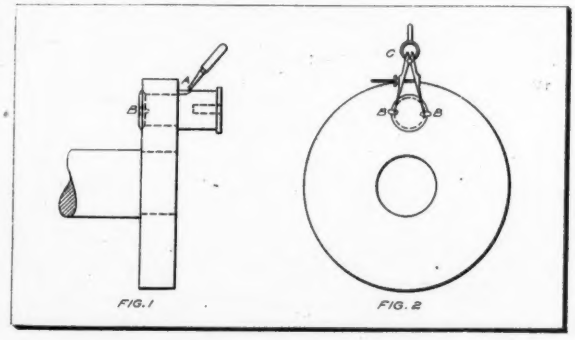


FIG. 1. GOUGING GROOVE IN CRANKPIN
FIG. 2. GROOVES GOUGED TO FIND DIAMETER OF PIN

From the knowledge I had of engines I packed what I thought would be needed, which included hammer, chisel, gage, file, calipers and dividers, also a combination square and tape. The superintendent told me, in his way, of the trouble and also impressed on me the importance of keeping the mill running each day.

I arrived at the mill about 5:30 in the evening and I had about one hour and thirty minutes to ascertain the trouble and remedy it if possible.

The mill had been closed down that afternoon, but they had kept up steam. After an examination of the crankpin, I requested the engineer to start up the engine. Sometimes water in the steam line will cause a loose pin and sometimes a hot pin will terminate in a loose pin—but the way those brasses pounded that pin convinced me that we did not have far to go for the cause.

To shorten matters, we tightened up the brasses till little of the knock was noticeable and found that the pin was slightly loose; I then assured the superintendent that he could run the next day, if he wished, without resulting in any disastrous breakdown.

I gouged a small groove in the pin at A to see if the pin set in a counter bore, and found it did not.

On the back of the pin I gouged out 2 grooves diametrically opposite and deeper than the peening counterbore, illustrated at B, at the divisions of the iron and the steel I made prick punch marks and placed the divider's points in these marks, as illustrated at C; this gave me the bore of the hole.

I asked the engineer if they had an emery stone in operation which, fortunately, they had, and it was

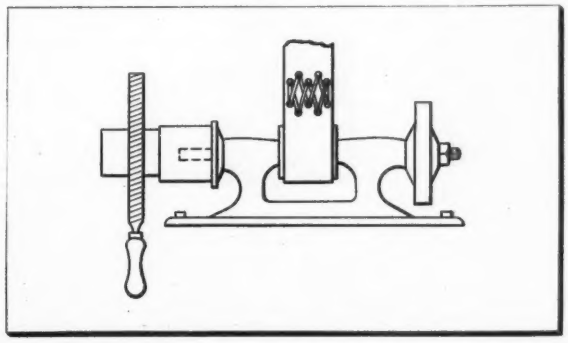


FIG. 3. EMERY STONE ARBOR USED IN LIEU OF A LATHE

a standard size thread for the nut that held the stone on. I knew that it would be necessary to make the pin larger than the size indicated by the dividers in order to allow for the looseness of the pin and any possible error that might have resulted in the measurement as well as to have it somewhat large for a tight fit; so I had the pin made 1/32 in. larger than the divider's size and had the large end bored and tapped to suit the emery stone arbor.

The pin was turned at the shop the next day and I put it in that night. It was no trouble to get the old pin out; by cutting away the peened part with a gouge we were able to drive it out with a hand hammer. I found the hole out of round and somewhat tapered; I filed it as nearly round as I could and then

after calipering the hole and the pin I found the pin somewhat too large, as I expected, so I screwed it in the emery stone arbor and filed it down to the proper size, allowing about 0.006 in. for a tight fit.

I warmed up the disk by building a fire about the hole and after greasing the pin with cylinder oil and graphite I placed it in a bucket of cold water. When the disk was warmed up till it showed the hole about the thickness of a piece of paper larger than the pin we drove it in with a piece of shafting suspended by a rope from a timber above; we could easily have driven it in with a sledge, but we wanted to make sure that it went in while the difference in the sizes permitted it. We backed up the disk in the back of the hole with a piece of shafting, and also backed up the pin with the shafting when we peened it.

After scraping the brasses to a bearing we set the keys up so that there was no knock and the pin would not run hot, although it did run a little warm when we first started. I told the engineer to make sure that the pin was always oiled and to keep the brasses up so that there was no knock and not so tight that it made the pin run hot and I thought he would have no further trouble.

Six weeks later I was sent to the same mill to put an outboard bearing on a generator engine and was told that the engine with the new pin had been operating satisfactorily since, giving no trouble whatever.

Of course there is more or less that the roadman has to take for granted and on this occasion it was the straight fit of the pin in the disk; if it had been a tapered fit it would have been necessary to chip off some of the journal part of the pin in order to let the pin go further in the disk and even at this not enough would have stuck through the disk to peen in a satisfactory manner, but no doubt it would have held till a new pin was made. But as engines with tapered crankpin holes are not common, I felt reasonably sure that this hole was intended for a straight fit. This is an example of the things that are continually coming before the roadman and usually no one but himself to solve them.

MARINE FEED-WATER HEATER LEAK

THE following incident told in International Marine Engineering by D. Kooijman is instructive in all its details:

On a tug which was making her trial trip a feed-water heater was placed at the back of the engine between the low-pressure cylinder and the condenser; the feed-water was forced by the feed pump through copper tubes, attached to 2 tube plates, which were bolted to the cover of the heater. The tubes in the feed-water heater were exposed to the exhaust steam and thereby heated. To get the feedwater into the boiler at very high temperature, it was further heated in a second heater, into which steam from the intermediate pressure receiver was admitted. The water from the hot well was led into an oil filter, from which it was taken by the feed pump.

On the trial trip, some hours after the starting of the engine, it was seen that the water level in the boiler was falling, and that at the same time the pipe A gave much more water than at the beginning of the trial. The feed pump proved to be in good working condition, and it was then understood what the trouble was.

The packing material between the tube plates and the cover of the feed-water heater was too thick and had given way, so that the feed pump did not pump the water into the boiler, but forced it back into the condenser. This water was delivered again by the air pump into the filter, so that the pipe A gave too much water.

On stopping the engine the water in the feed pipe was all forced into the condenser, and on opening an air cock inserted on the air vessel of the feed pump the noise of the inflowing air was heard, which proved that the suggestion was true.

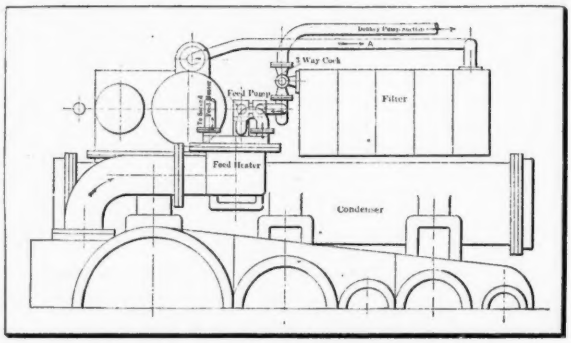


FIG. 1. LOCATION OF FEED-WATER HEATER

The engine was started again, and the feed-water from the 3-way cock pumped into the boiler by the donkey pump. After a half hour, in which the mishap was thoroughly discussed, the level in the gage glass was again examined, but the water was no longer visible in the glass.

The first thing was to draw the fires and then to hunt for the cause. It was soon found. The donkey pump forced the water into a valve chest, in which it could be led to the boiler, overboard and to the feed tanks. Between the overboard valve and its seat a small piece of stone had become lodged, so that the valve was not closed and the water was pumped

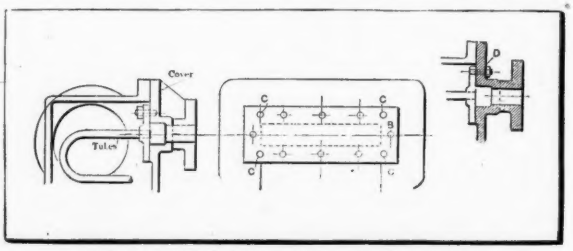


FIG. 2. DETAILS OF HEATER CONSTRUCTION

overboard. The spindle was turned back and, on shutting, the valve was now closed very well, and the feedwater pumped into the boiler, in the gage glass of which the level was soon visible again. Afterwards the boiler was inspected, but nothing out of the way was discovered.

When the cover of the feed-water heater was removed, the packing showed itself to have given way at B, where the pitch of the studs was rather wide. The studs C were added and the tube plates packed with very thin packing material. The heater has given no further trouble, although it would be better to put the studs in the tube plates, as indicated at D, and have the nuts placed on the outside. Then it would be possible to tighten up the nuts after the whole apparatus had been warmed through.

LODGE NIGHT

Brother Toomey Reports the Convention

By John H. Ryan

ATTENDANCE at our last meeting was larger than usual, as the delegate to the convention was expected to make his report and we wanted to know what happened to some of the vital questions we had been arguing about for the past year. Delegate Toomey was hazy and indefinite about the actual proceedings of the convention, but his description of the good times he had with the good fellows he met made each member register a personal vow to try to cop the job next year. With 150 candidates in the field the chances are that Brother Toomey will be sent back again. He stated that he would not take up too much of our time in one evening, and that he would merely outline his impressions and would report on the proceedings in detail at the next meeting. Some diplomat, that boy! The papers will be out by that time and he will be able to find out what was done at that important gathering of which he was an active participant.

While Brother Toomey was speaking, Jim Holmes passed around some snapshots that showed Brother Toomey as the official Mormon of the convention. He was depicted with a megaphone, leading 47 females over to the bridge so they could admire the willows growing on each side of the river. Brother Toomey justified his actions by the plea that someone had to be the goat. There was considerable more joshing on the subject and the convention was forgotten.

It's peculiar how people like to talk about things of which they know nothing. The reasons which underlie some of these things may be beyond their range of experience, but they must have an oar in. The good-natured joshing of Toomey got old Joe Gaynor to thinking. He has been a widower for 30 yr. and his married experience covered a period of less than a year. He got right up in righteous wrath and spoke.

"It's a positive disgrace to our organization, the manner in which some of the members use the fair name of the association to make the lies they tell their wives sound more plausible. Some of the ladies in this town think we have a meeting here every night, at which different branches of engineering are discussed and of course poor hubby has to go so he can keep up-to-date on the newer things of his business. See what happened here last week.

"Last meeting night Joe Burns' wife went to the dressmaker and when she was through it occurred to her that it would be pleasant to meet Joe at the hall and they could take in the last show at some moving picture house. She came up to the hall and asked for Joe. Our rapid thinking conductor at the door said that they were working overtime and Joe had volunteered to work in his place so the conductor could attend the meeting and pay his dues. Toomey was out after cigars and he met Mrs. Burns at the foot of the stairs. She mentioned that she was up looking for Joe. Toomey didn't wait to hear any more but said that Joe was a trustee of the sick benefit and he had gone over on the west side to visit a brother who was laid up with rheumatism. He excused himself and ran upstairs; at the door he told the conductor of meeting Mrs. Burns and the story he told her. They thought the best thing to do would be to run after her and apologize. She was out at the corner waiting for a car when Jack Haynes came along and told her that he had just left Joe over at the central station, where they were making important tests and Joe was observing them in the interests of the lodge.

"Well, Joe got home at his regular time and his wife very sweetly asked him about the proceedings at the meeting. She let him tell about the great benefits he was deriving from the educational feature and then she told him what she thought of engineers in general and himself in particular."

Gaynor's talk made considerable impression and under the head of the good of the order it was regularly put and carried that the conductor be given a monopoly in imparting information to visiting ladies, and all other members were required to refer visitors to the conductor so that they would receive the brand of information they were used to getting.

The question box had a few inquiries of local interest about the manner in which certain work could be done. The discussions of the questions were quite general, the most noticeable thing about these discussions being the unusual faculty of the members for wandering from the subject. One brother started to tell how he would get out follower bolts that would break before they would start to unscrew and he wound up with an analytic discourse on the erosion of turbine blades.

Convention delegates should be electrocuted after they have made their report. This would save the members from listening to the stereotyped preamble to everything they say. Here is the first one we got from Toomey. "Coming down the hill from the depot in the convention city I met one of the local committee who was changing a rear tire on his Lozier and he used an ordinary carpenter's brace with an inserted chuck large enough to grasp the outside of the clamp nuts. I find a lot of places around my plant where the brace is useful for other things than boring holes, for example, opening and closing small valves from which the wheels have been lost or broken, or where it is desired to keep certain persons from using the valves. For grinding in valves the job can be done better and more quickly if the hand wheel is removed and a brace used in its place. It is the best tool for opening the valves on anhydrous ammonia drums, as they are small stemmed and are packed tight. For tapping out holes the ratchet brace is better and more convenient than a tap wrench or the ever ready monkey wrench. It is handy for twisting wires when a strong and flexible wire is needed for cleaning out piping or sewers.

"The greatest use of a brace I ever saw was on a job a cub engineer did who did not realize what good ingenuity he was applying. He was running a 15-hp. engine and one morning when he overslept he started it too quickly and nearly broke it up with water. There was a cold shut in one corner of the connecting rod strap and the jar from the water opened it up. He was afraid to tell the boss and ask for a new one, so he picked up a piece of 3 by 1-in. iron and made one. He had a ¾-in. tapered reamer and with a hole in a piece of 2 by ¼-in. iron for a bearing for the large end and a spike in a hardwood block for a center, he surfaced that strap on its 4 sides. His driving power was applied with an old brace and his work was made to feed up to the reamer by the screw of the bench vise as it projected through the back of the vise. The finished job was first class and the young fellow thought he was only following the precept that says: 'Self preservation is the first law of nature.'"

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

ELEVATOR CABLE ARRANGEMENT

ACCOMPANYING sketch shows the cable arrangement and safety-brake of a traction elevator installed in a New York hotel. As the machine is a new one on the market and a departure from elevators now in use this description may be of interest to engineers who are not familiar with it.

Cable arrangement is a striking feature and appears to be an improvement on that used at present. As shown in the sketch, the lift and drive cables are entirely separate from one another. The lift cable is simply a single length having but one bend in it,

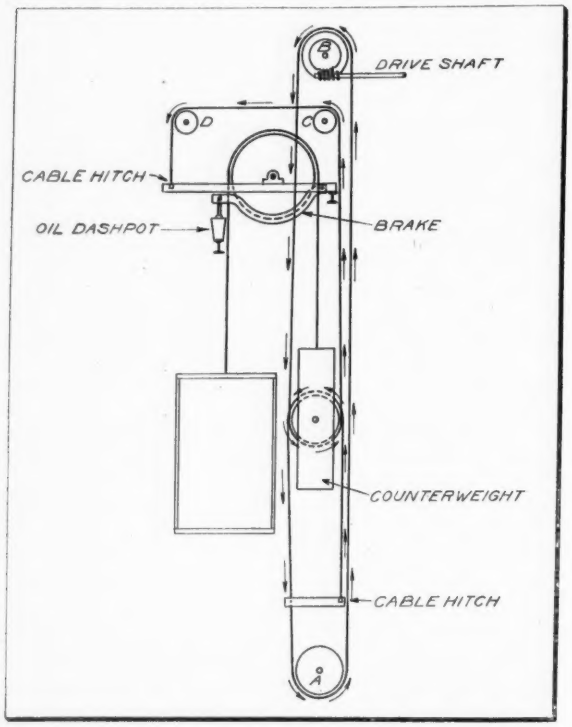


DIAGRAM OF ELEVATOR CABLE SYSTEM

the ends being fast to car and counterweight respectively, this naturally tends to lengthen the life of the cable and reduces the labor cost when a renewal becomes necessary.

The driving cable is made fast in a hitch near the bottom of the shaft, and leads up and over the sheave in the counterweight, down to the sheave A, up over the driving sheave B, down to the counterweight again passing over the under face of the sheave and up to and over the sheaves C and D and is finally hitched near the end of the tiltbar which operates on the lever principle and supports the weight of the car and counterweight.

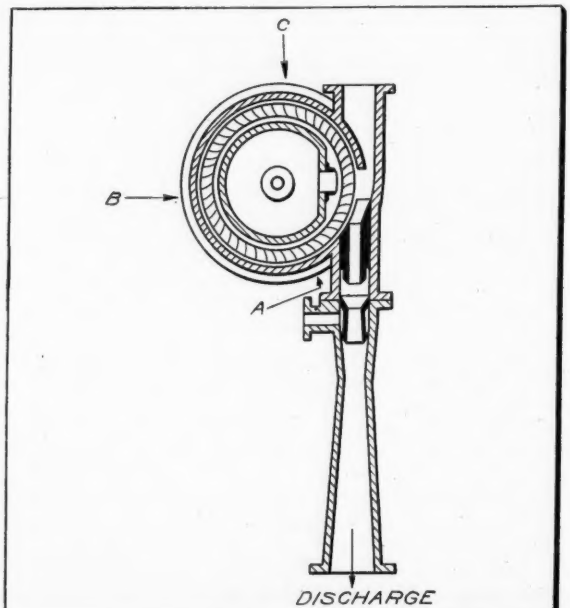
It will readily be seen that the tractive energy required to start the car depends entirely on the weight supported by the tiltbar. The heavier the bar is loaded, the more tension is exerted by the tiltbar on the drive cable, thus increasing the traction. This method eliminates to a great extent the waste of current which is common where the traction is fixed.

The safety arrangement is a practical as well as novel one. The drive cable which is weaker than the lift is designed to part when there is any under strain; this causes the tiltbar to drop into the brake under it; the oil dashpot shown in the sketch is designed to absorb the sudden shock due to such action.

A. Pohlman.

COVERING HOLES IN AIR PUMP CASING

IN a plant where the writer was employed there was a La Blanc condenser with turbine-driven centrifugal water pump and air pump. Both pumps were in one unit; i. e., the propellers of both pumps were mounted on one shaft and the casings of the pumps were bolted together. Speed of pumps was 1500 r.p.m. and the water supply for the air pump was filtered city water. After the pumps were in opera-



AIR PUMP WHICH DEVELOPED HOLES

tion about 8 months, several holes about the size of the point of a lead pencil developed in the air pump casing at A, as shown in the cut. When the pump was stopped a form was built about the casing at this point and filled with concrete; the pump did good work until a new casing was received.

The new casing developed a hole in the same place in about 6 months. Some asphaltum paint and sheet packing were put over the hole and a form of tin put on and filled with concrete without stopping the pump. About 3 weeks later a hole developed at B and later another at C; these were repaired in the same way by extending the form and filling it with concrete. The metal seemed to be cut away, possibly by the water due to the high speed of the rotor.

C. E. N.

WATER COLUMN CONNECTIONS

I READ with interest the friendly criticism on the method of connecting up a water column, appearing on page 947 of the October 1 issue of Practical Engineer, by Thos. C. Robinson, as given by the writer in the September 1 issue.

In response I wish to say, that the better practice warrants the use of ground unions on pipe sizes up to 3 in., as these are more reliable than the packed joint union, and when properly put on a pipe, and the pipe in line, will make a lasting and dependable joint. In support of this contention, let Mr. Robinson ask the insurance inspector's opinion on his next visit to the plant.

In regard to making repairs on the column when under pressure, I did not mean that it was advisable to take the column down while the boiler was under pressure, but that oftentimes a gage cock will leak or the blowoff valve at the water column will need repairs. Then again, the nipple that usually connects the tee used in the connection to the water space of the boiler, and the blowoff valve have been known to break. When valves are used in the connections, these repairs may be made without difficulty and the necessity of emptying the boiler, even though we wait until pressure is all off.

Connecting the steam gage to the water column is not necessary to the operation of the column, but is done in my practice for the following reasons:

To connect the gage at any other place, as to the shell or steam pipe, is inconvenient; the small pipe leading to the gage is not very strong and when of any length and exposed, is liable to injury, and the longer the pipe the more liable to become clogged.

When connected as suggested, the gage can be seen when looking at the water level, and this is desirable, and when the attendant looks at the water level, he sees the gage and usually this leads to the maintenance of steadier pressure.

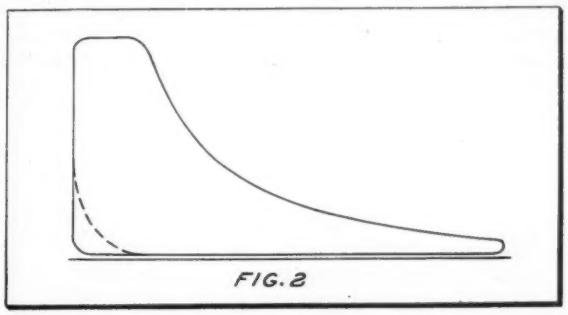
In regard to blowing down a column, the fact that the greater part of the discharge is steam when valves are not provided, is due to the fact that the steam moves through the pipe with less friction than the water to begin with, and as the direction of the steam is downward to begin with, and that of the water is at right angles to this direction, the steam has a dampening effect on the water flow, the same as when 2 drip pipes discharge into a tee, one will hold back the other.

The writer does not say that the movement of water in the glass under all conditions is a correct indication of the water level, but maintains it is one of the best signs that the connections are clear. In many gage cocks, while the shank is cut with a standard of ½ or ¾ in. thread, the hole through the shank is 3/16 in. or even less. Water gage valves which the writer has examined have had an opening of at least ½ in. at the smallest place, unless provided with some kind of ball valve to shut off the glass automatically when it breaks.

Therefore, the writer would rather have a column provided with 2 water glasses on opposite sides of the column, which showed the water to move up and down slightly, due to natural conditions within the boiler, than to have gage cocks, because the opening is larger and not so liable to clog up. Receiver.

COMPRESSION IN CORLISS ENGINE

IN answer to M. W. in the Sept. 15 issue in regard to the proper valve setting of a Corliss engine, F. L. Johnson states in the last paragraph, "This valve setting (16 by 42 in. at 96 r.p.m.) should give an indicator diagram similar to the sketch, which represents the best possible steam distribution in a Corliss engine cylinder." The diagram shown in his Fig. 2 shows little compression, the corner being only slightly rounded. The question of what is the proper amount of compression will never be settled satisfactorily to all engineers; but at the Kansas State University a 10 by 30-in. noncondensing Corliss engine with about 7 per cent clearance and running at a speed of 112 r.p.m. gave the highest steam economy with compression to about 45 per cent of the absolute initial pressure. The exact compression which should be carried on engines of different types and speeds cannot always be determined without trial. Professor Carpenter at Sibly College made a similar test on a triple expansion engine and found that as the compression increased so did the steam consumption, but he did not use a compression lower than 42 per cent of the initial pressure. Although I have never had the opportunity to make accurate tests along this line, I believe that a Corliss engine will give better steam economy, and run much more quietly especially at high piston speeds, with higher compression than Mr. Johnson states, and would suggest that the proper compression be about as shown dotted on his diagram. J. C. Hawkins.



COMPRESSION CONSIDERED IDEAL FOR CORLISS ENGINE BY MR. HAWKINS

AIR IN BOILERS

REFERRING to the article "Air in Boilers" on page 947 of Oct. 1 issue, I think I could give another suggestion, but it may not apply to Mr. Holleran's statement.

Where I am employed we have 2 Wickes vertical water-tube boilers. On Saturday nights, in warm weather, we let the fire go out in both boilers, one of which is cooled down for cleaning.

After this boiler is cleaned it is filled with city water. Fire was always started early Monday morning under both boilers at the same time. Soon after starting we had the same trouble; the pressure would

fall fast. On the boiler which had been cleaned previously, the water would rise from the first gage until it was out of sight and had to be blown down. This showed that the boiler had not been steaming.

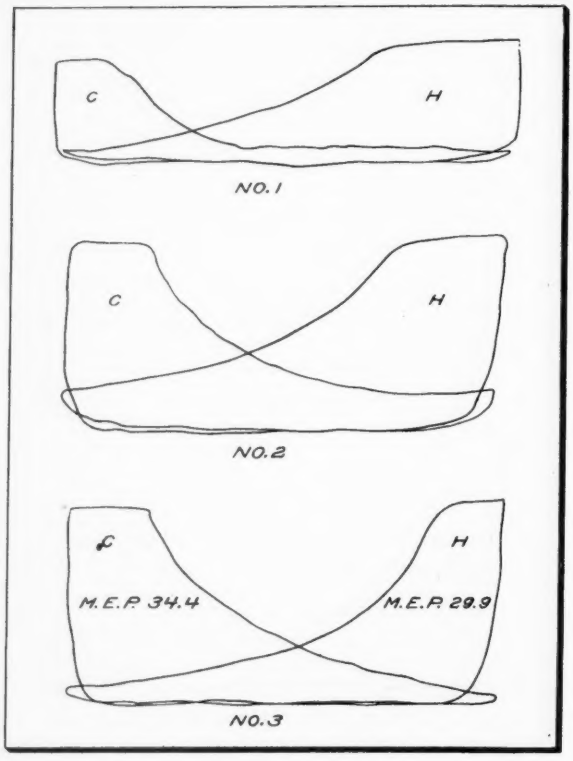
After going under the boiler where the blowoff pipe enters the boiler, we found that we could lay our hands on the bottom drum; this showed that the water had not been in circulation long. These boilers have the circulation of a U-shaped boiler. After this the cold boiler was always fired first until the hand on the gage raised off the pin, then fire was started under the other and we had no more trouble.

Otto H. Dreyer.

VETERAN ENGINE STILL WORKING

INDICATOR diagrams herewith are from an 18 by 48-in. Reynolds Corliss engine, running 72 r.p.m., noncondensing; has been in service about 30 yr., during which time it has been through 2 fires and partially rebuilt once.

Diagram No. 1 was taken about 4:30 one morning after the watchman called us out of bed with the information that someone whom he could not catch, had been monkeying with the engine. No. 2 was taken after a little adjusting, and No. 3 some hours later. The coal consumption on the 5 days following, for 11 hr. was 4650 lb. of Hocking screenings, which we considered good, as we heat considerable space with live steam, and run 5 dry kilns.



GOOD CARDS FROM OLD ENGINE

Last winter the exhaust chamber developed a crack 24 in. long, which was fixed by welding; also an old crack clear around the crank end exhaust port, which had been repaired in the days before cast-iron welding was known, by boring out cylinder 14 in. and putting in a bushing. In the welding process this bushing sprung 1/32. in., which we scraped out by hand, as we are going to consign the old engine to the scrap heap and get a new one in a year or so.

Taking it all in all, considering the conditions the engine is in, we think the cards are pretty fair in comparison with some taken before I came here.

Assistant

CHANGING CHIEFS

OUR chief engineer was one good fellow. Everybody in the plant liked him. Things ran along with little trouble. When the boilers fired hard he put on an extra man. When the repair man cleaned a boiler, chief would say, "Well. how is she Bill?" and the repair man would answer, "Oh, pretty fair." And the boiler would be closed and started on its way, making steam at Bill's say so.

Some time ago our chief came in to bid us all "goodbye." It seems the company did not appreciate him and would not get him necessary supplies; they thought he had too much help and that it was costing too much per kw. for power.

We were all surprised, as we thought our chief was the last word in engineering, and if anybody could make the kw.'s cheap, he could. But it seems the company thought differently.

Anyway, one of our operating engineers was installed as chief, which made us all jealous, of course. The first thing he did was to call us all together and give us a little talk like this: "Now, men, I am put on as chief to clip a little of the kw. cost, and I'm going to do it with the help of this force; but I'm going to do it or let someone else have a try." Turning to the repair man, he said, "We will start to clean No. 1 boiler when the load goes off tonight; take all the help you can use, give her a good cleaning and have her ready for the peak load tomorrow afternoon, if it is possible."

The repair man said, "We cleaned No. 1 last week." The chief said, "All right, just do as I say." I laughed to myself, for I had seen Bill clean a boiler and so had the chief. Bill used to cut the boiler out, about half past 10, p.m., and cool it down as quickly as possible, open it up and then he and the helpers would go to sleep.

This was the way he intended to do it this time. But just as he got the ashes out and cleaned from the back end and the boiler washed out, who arrives but chief! He said, "Well, how is she Bill, been inside?" And poor Bill was so much surprised, he said, "Yes, sir, and she's clean, just as I told you." The chief said nothing, but started for his office, and the next thing we knew he was in our midst, dressed in a suit of overalls made union shape; taking the extension light from Bill's nerveless hand he crawled in through the front manhole. He was in about 10 min., and when he came out he gave Bill such a nice quiet talking to that Bill wanted to get through, but the chief would not hear of it.

The only part of the conversation I heard, was, "Bill, you can lie to me about anything else you please, but don't lie about the condition of the boilers."

They sprayed kerosene all over the inside of the boiler, especially the back head and tube ends, closed it up and went to sleep. They slept about 4 hr., then had breakfast and opened it up. By scraping and digging they removed about 2 bushels of scale and some of it was pretty thick and some was an accumulation of old scale formed into a solid mass. They washed

it out, closed it up and filled it with water and most of the tubes on the bottom rows were leaking; then he had the flues scraped and in some of them the scraper had to be driven through with a sledge hammer; then he rolled the leaking tubes and put a fire under it and had steam up in time for the peak load.

He went through all the boilers the same way, with the same result, and he is feeding a boiler compound, as he says he only got the rough of it out.

Now, we can run through the peak load with one boiler cut out and have one less man in the boiler room. We get more waste to clean with, better oil, but considerably less of it.

We have 2 new indicators and reducing wheels and a power cleaner for the economizer tubes.

We are not docked when we lose a day and everything is lovely, still the help does not like the chief, strangely enough he does not seem to care, as he has cut down the coal consumed per kw. about half a pound, and that was his object. Thomas Sheehan.

CREEP OF BELTS

THE writer is an interested reader of Practical Engineer and has read the article on "Creep of Belts" by W. F. Schaphorst, in the September 15 issue.

The writer does not quite grasp the point Mr. Schaphorst makes when he says on page 889, "When power is transmitted by a belt it is thus evident from the above that creeping must occur between the belt and both the driving and driven pulleys, and that the number of revolutions made by the driven pulley is not so great as determined by the formula

$$N_2 = \frac{N_1 d_1''}{d_2}.$$

In order to place the writer's point before you, we would state that he is operating a 120-in. blower, with an open belt 20/64 in. thick, driving pulley 24 in. diameter, driven pulley 20 in. diameter. Speed of driving pulley 285 r.p.m.

Substituting these values in the above formula, we have $N_2 = \frac{285 \times 24.3125}{20.3125} = 341.12$

The writer has taken the speed of the driven pulley with a speed indicator carefully and finds it to be 341 r.p.m. This he believes rather to upset the statements made in this article, or else the writer has overlooked some vital point which he believes Mr. Schaphorst will be glad to explain through your columns. I. R.

I have checked I. R.'s figures and find 341.12 r.p.m. to be correct with substitutions made in the formula

$$N_2 = \frac{N_1 d_1}{d_2}$$

The speed indicator reading, however, is confessedly large, 1.5 per cent frequently being allowed for creep. This would bring the speed of the driven pulley to about $341.12 - (341.12 \times .015) = 336$ r.p.m. instead of 341 as actually determined.

Nevertheless 341 r.p.m. would be mathematically possible by using a very wide belt, thus reducing the unit stress in the pulling side of the belt to such an extent that the ratio $\frac{E + f_1}{E + f_2}$ would be nearly unity.

Since such conditions would hardly exist in practice the writer is of the opinion that a slight error was made by I. R. in reading the revolutions of one of his pulleys despite his declaration to the contrary. The only other possible explanation would be that the belt, while readings were made, was pulling zero load. This also is improbable where the belt is driving a blower.

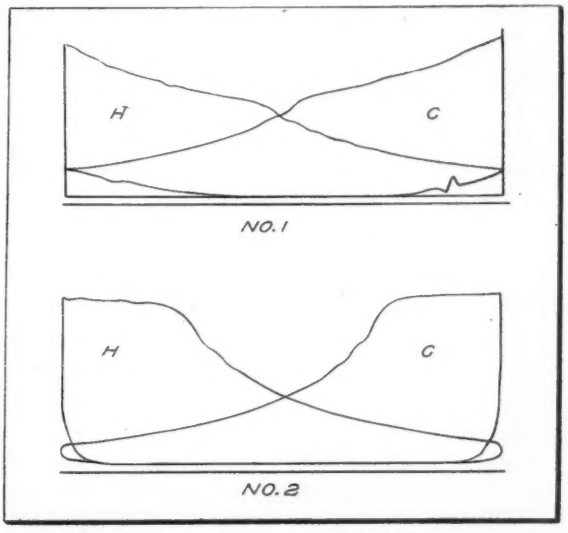
Both pulleys should be read simultaneously, if possible, and with great care. By extending the observation over a period of 10 min. and dividing the total revolutions during that time by 10, results should be more satisfactory.

A belt that pulls with no slip and with inappreciable creep is a rarity, and, as the writer showed in the first article, the steel belt can approach that state more closely than can a leather belt because of the higher modulus of elasticity of steel.

W. F. Schaphorst.

OVERHEATED BABBIT: INDICATOR CARDS

I SAW an article in July 15 issue of Practical Engineer about overheated babbit. Something similar to this came under my observation once. It was caused by the washer on the crankpin clamping the rod brass. As the brass warmed a little it expanded and in a few minutes it was hot and the babbit started. The engine was slowed down, ran a couple of minutes, then stopped; meanwhile the crankpin was deluged with oil. Upon examination it was found a narrow strip of babbit, about ⅜ in. wide, had been entirely melted



ORIGINAL AND FINAL CARDS FROM A CORLISS ENGINE

out. The rest of the babbit was in good condition, the melted portion occurring next the crankpin washer. Brass was repaired, and paper washers used between end of pin and washer. No more trouble was experienced.

I was called upon to indicate a 16 by 36-in. Corliss engine. The purchaser had it erected by a man supposed to be a good erector. There was a double eccentric and I found the engine in condition shown by card. The engine was making more or less noise. After throwing exhaust eccentric ahead, and making a few changes in rods, I obtained card 2.

Tom Jones.

PLANS ARE UNDER WAY for the erection of a big power generating plant in Syracuse, to furnish power for the lines of the New York State railways, and current for the Syracuse Lighting Co.

SHAFT GOVERNOR ACTION

I WAS much interested in that governor question which relates to a change in lead—page 950, Oct. 1 issue. The answer given on the next page is correct, but I would offer something further in connection with the matter that may be of interest to your readers.

Nearly all, if not all, shaft governors involve the same principle, that of shifting the eccentric to change its throw and also change the angle of advance. In some governors—the Erie, for instance—the eccentric is constrained to move across the shaft in a straight line path, and at right angles to the center line of the crank. With such a governor lead remains constant for all points of cutoff, the throw of the eccentric decreases, angle of advance increases, all the steam events, excepting the lead, occur earlier.

In some other governors the eccentric swings across the shaft in a curved path, then the lead increases or decreases as cutoff becomes earlier, according to whether a direct or indirect rocker arm is used. When the eccentric is hung on the same side as the crank, the load increases as cutoff becomes earlier. But if the eccentric is hung 180 deg. from the crank, then the lead decreases as cutoff becomes earlier; this occurs with a direct rocker and direct valve. With an indirect rocker or valve, the opposite conditions will occur, concerning lead.

When the eccentric is on the same side as the crank, but not on the center line of the crank (that is, suspended on one side of the center line), the lead decreases as cutoff occurs earlier.

The Begtrup governor may either increase or decrease the lead as cutoff occurs earlier, according to whether a direct or an indirect rocker arm or valve is used, as before explained.

In some other makes of governors the eccentric is turned around the shaft so as to vary the angle of advance without changing the throw, and because of a double valve being used the point of cutoff only is affected, the other events remaining the same.

It is an open question whether it is preferable to have the lead constant or to have it change as the cutoff changes. It would be interesting to hear what Practical Engineer readers have to offer on this subject. Charles J. Mason.

WATER HEATING KINK

CONCERNING the exhaust steam connections which O. B. C. has connected to his feed pump, in which he uses hot water from the discharge pipe to condense the steam, I would suggest that, if he has no other use for the exhaust steam, he install some kind of an oil separator in the exhaust line and then, instead of using water from the discharge line, that water from the tank line be used to condense the steam. Or he can place the condenser in the main suction line and run condensing all the time. This change will not heat the water quite so hot as it does at present; but he will gain just as many heat units as he does now, and use less steam, as he is pumping some of the water against pressure the second time. If placed in the tank line, the valve in that line could be left open just enough to condense the steam, and the balance of the water taken from the pond line. There are some small pumps, notably the "Marsh," in which the exhaust steam line is connected directly to the suction line, and the pump runs condensing after it is started. J. C. H.

IMPROVING THE WATER SYSTEM

ON taking charge of my present power plant I found a weak water system. We have a well of fine water coming out of sand rock. The well is 60 ft. deep, dug, and blown out big at the bottom; our roof tank is 100 ft. above the water, making a good lift.

The old system was built on this plan: A pump jack built up on an old wood frame, with a bent plunger rod, that could not be packed, threw water as high as your head. The guides were wired to the frame, the wires would break, and then it would move. A brass cylinder hung down almost to the bottom on the end of a 2-in. pipe, with ⅜-in. sucker rods that would break and flop against the sides of the pipe. They had worn out the threads, pulling this pumping plant out of the well, and putting it back. The stroke was 2 ft., brass barrel 4 in. by 42 in.

I had not run 2 weeks till it broke down one Sunday night, but I had enough water to put me through. Next day we pulled it out and fixed the rods; this took all day. When we tried it, in the evening, all was right for about 15 min., when the rods pulled apart. We piped water across from the lumber yard and used city water that night.

Next day the boss handed me 2 ejectors that he had in stock, but for some cause they had never felt water go through their veins. The electrician and myself put them in the well—first ejector at the water, second one 25 ft. above. At 4 p.m. we all held our breath when the steam was turned on. There was a rush of steam, showing joints were good, then came that song of the jet family that is pleasant to hear. Eighty pounds of steam was the lowest pressure with which we could pump water up into the tank. I used this method for 5 months; it was a little hard on the coal pile. One day we collared a supply man and bought 55 ft. of galvanized, 4-in. pipe, plugged and reamed large wood sucker rods, had a new plunger rod made, built a new frame, made a longer connection rod, and braced the guides with straps of iron. One year has passed without breakdowns.

We use a little slide valve, 6-hp. engine, and 4-in. leather belt. The pump runs 25 strokes per minute. The advantage is, we can now get water 2 ways, with high or low steam. When I repiped the steam line, the largest pipe they had was 1 in. and had crooks galore. I started out with 1½-in. pipe, then down to 1¼-in., then to 1-in. I can now use both together if needed. The jet will work with 10 lb. of steam less, but I use it only enough to keep it in order.

G. H. Brough.

EFFECTS OF SHIFTING ECCENTRIC

REFERRING to the article by A. C. Waldron on "Effects of Shifting Eccentric of Slide Valve Engine," published Sept. 15, card No. 24 was taken with the eccentric set 165 deg. ahead of the crank on the backward motion, so it is no wonder the engine ran backwards as he says it did. But No. 23 is the one that is strange, as the eccentric is set 175 deg. ahead of the crank on the backward motion, and yet, he says, the engine would run forward.

After it was started the momentum of the fan might carry it over center, but I don't see how he ever started it, as the engine has everything against it before passing center.

Also, No. 13 shows a leak past the piston or drip valve. R. M. Packingham.

Successful Kinks From The Plant

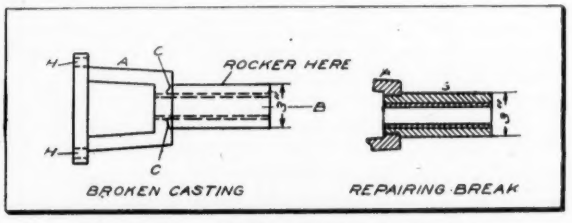
For Saving Time, Work and Trouble

Repairing a Corliss Engine

JOE, the engineer, brought the whole assembly of casting, rocker arms and valve stem in to us while it was still hot. He had taken out the 4 bolts at H, the hole B needed a new bushing the worst way (the stem did shake a good deal), and he had to put it back so they could start up again after dinner, because their other Corliss engine was too light to carry the afternoon load.

When we got the parts stripped off the bonnet casting, we found the turned end, on which the rocker fitted, broken completely off as shown at the irregular lines C C in the drawing—no wonder the stem did shake around a bit! I called Joe on the phone and told him to telegraph the factory for a new casting at once because this one was no good and never would be. He said he would but that the old one had to be fixed up to run until the new part came. That settled it. I would fix it up if he would take the responsibility.

So the casting A was put in the lathe, bored out on the end, and threads cut in it. Meanwhile another man had bored out a piece of cast iron G to fit the old bushing (which was in good shape). This was



REPAIR TO A CORLISS ENGINE VALVE GEAR

turned to 3-in. in the outside and one end threaded to fit very snugly in the threaded end of A. Liberal "rounds" were made in the corner to reduce the chance of future breakage. When the new casting had been screwed by the aid of a 4-ft. bar, I was sure it wouldn't work loose.

Joe got the outfit back in time to start up at 2 o'clock and when he took it out a week later to put in the factory part, it looked good for months to come. He has put it away in the closet with the "spares."

D. A. Hawpson.

To Loosen a Rusty Union

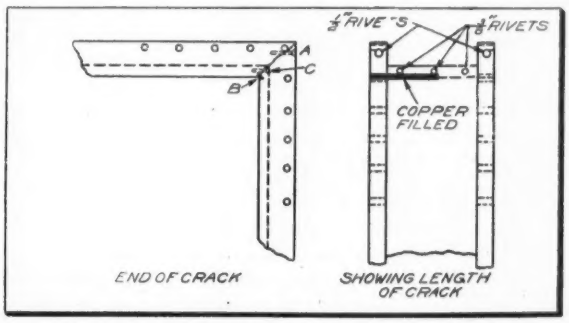
IN Gas Power, Even Herbert describes a method he has used to remove a rusty union, as follows:

The pipe was a waste pipe from a sink and the union elbow was in an awkward place under a joist where I could not get a good hold on it. After trying all sizes of wrenches up to 36 in. and the union would not let go, I came to the conclusion that it was necessary to adopt other methods. So I wrapped a rag around the union, keeping it from the pipe as much as possible and only touching the elbow. This rag I saturated with kerosene and set fire to it, but had to be careful not to set the joist on fire. After the oil had burned out the elbow let loose without much effort, the heat having expanded it sufficiently to loosen—it perhaps also broke the rust.

Repairing a Steam Chest

THE steam chest on a hoisting engine cracked half through the corner, as shown in sketch, and I repaired it in the following way:

I first drilled and riveted the crack together, as shown at A and C, to prevent its cracking any farther across, and then chipped a dovetailed groove the length of the crack, as shown at B, and tamped it full of



CRACKED STEAM CHEST AND METHOD OF REPAIR

copper, which firmly wedged in the dovetailed groove, and as the rivets held the crack firmly together, it could not open up, no matter how tight the copper was tamped in.

This proved to be an effective repair and not the slightest trace of steam escaped. I have also repaired cracked steam and water cylinders in the same way, by chipping a dovetailed groove and tamping them tight with copper.

E. Stevens.

A CHIMNEY 506 FT. high, the tallest in the world, has been built for the Boston and Montana smelters at Great Falls, Mont. Its nearest rival is 40 ft. shorter and the next highest in America is 140 ft. shorter. The main barrel of the chimney has an inside diameter of 50 ft. at the top and about 65 ft. at the base; its discharge capacity is 4,000,000 cu. ft. of gas per minute. There are 17,000 tons of brick work in the entire structure and the foundation, which is 103 ft. across at the bottom and 22 ft. 6 in. high, contains 4300 cu. yd. of concrete. An octagonal base, 78 ft. 6 in. across at the bottom and 46 ft. high, separates the main barrel from the foundation. A dust chamber, 478 ft. long, 176 ft. wide, and 21 ft. high, closely hung with small wires, strains the smoke before it enters the chimney. The flue which leads from the dust chamber to the chimney is 40 ft. wide and 1238 ft. long. The whole chimney has an acid-proof lining.—Popular Mechanics.

REJUVENATING THE PUMP

An Engineer Gets a New Pump at Small Cost and Much Valuable Experience

SABET

IN the power plant of a factory, the boiler feed pumps consisted of 2 single plunger, geared power pumps and one Knowles single steam pump.

The power pumps were of the old Geo. H. Corliss make and were about 40 yr. old and had been worn, broken and patched, and generally abused until it was useless to try to run them.

The Knowles pump was almost perfect on the water end, but the steam end was in bad condition by reason of lack of cylinder oil.

Altogether, it was somewhat of an uncertainty whether the water could be kept up in the boilers. Two pumps were required in the daytime and one at night (if they ran well).

After some investigation, the engineer told the manager that if he would buy a triplex power pump to take the place of the 2 old power pumps, he would overhaul the steam pump and make it operate as well as it did when new and without expense to the firm other than labor; but that, until he had a dependable pump, he did not dare to dismantle the steam pump.

The manager, after being shown the conditions and what was proposed, agreed; and, taking the engineer's specifications (which were so drawn as to enable the builders of any standard triplex pump to bid) immediately got prices and information on what was required. Then, calling up the engineer, he said: "Here are the figures, with complete descriptions; pick out the pump which will give us the most value for each dollar we pay for it."

When the new triplex pump had been installed, the Knowles steam pump was taken out and carried to the factory repair shop, where it was completely dismantled and every part requiring repair or renewal laid aside with any associated parts needed to facilitate fitting new work, and the remainder of the pump carefully stored to prevent loss or damage to parts.

First, the steam cylinder was rebored, about 1/16-in. cut being required to true the bore; this was done by strapping the cylinder to the face plate of a lathe and using a stationary bar, with travelling head, on the lathe center. This was done because, in this case, it involved less work than to set cylinder on lathe carriage and revolve the bar as is usually done.

Then the cylinder was taken to the planer and the main valve seat planed, removing the least amount that would give a true surface; this was a full 1/16 in. Then the main valve was planed on the shaper in the same way.

There being no material at hand of which to make new piston rings, the old ones were carefully peened until they fitted the new bore closely and then the ends were slotted and a piece of bronze fitted as a tongue piece to close the gap at the ends of each ring and each riveted at one end to its ring.

The piston rings and their grooves in the piston being considerably worn, the piston was mounted on an arbor and grooves trued up on the sides; as of course this widened the grooves, the follower plate was taken off and a facing chip taken off of piston to allow follower plate to pinch slightly the rings, then the rings were tried in the grooves and lightly filed on their edges where they were tightest and then finish fitted by grinding with fine emery.

The piston rod was badly worn, being in one place ¼ in. under size and presented a problem which was handled by making an entire new rod. The engineer had found in the store house an old bronze pump rod, history unknown, which was just large enough, by careful centering, to turn up to make the new one. Of course, this was not quite as hard on the surface as a drawn rod but was far better than using a steel rod.

The auxiliary valve and chest now claimed attention. The auxiliary valve was found to be worn so that there was about 1/32 in. play in the chest, accounting for the pump not working at all without nearly a full throttle.

This part of the job at first presented the most serious obstacles, but was handled in this way. The valve chest was mounted on the carriage of a lathe and bored out with a revolving bar carrying 2 cutting tools set opposite each other. Careful examination showed that 1/16 in. on a side could be removed without danger of leaving auxiliary port walls too thin at any point.

Then the auxiliary valve was taken in hand and a paper template made of the ports. First, a line was drawn on the side of the valve opposite the ports for its entire length and also scribed on the ends of the valve for future use, then a piece of heavy manila paper was wrapped snugly around and cut on the line, making the paper an exact fit over the whole valve with the ends opposite the ports. The ports in the valve at each end were then carefully imprinted in the paper, as well as the holes for the taper pin holding the T head of the valve stem. The template was then taken off, the ports and pinholes cut out, and laid aside.

It was found that the valve was centered at one end, but that the other center had been cut away when the lot for the valve rod head was milled; therefore, this end was carefully recentered, but not very deeply, as the head of the valve was not thick enough to permit of a larger center. The valve was then mounted on lathe centers and turned off about 3/32 or 3/16 in. on the diameter.

Then 2 castings, designed to be fitted up as pulley bushings were found which were clean and free from blowholes or sand spots; these were bored out 0.003 in. diameter less than the size to which the valve had been turned and then mounted on an arbor and a roughing cut taken off, leaving them about 3/16 in. thick. Thus these rings, each being of length equal to the bearing part on each end of the valve, would act as bushings to the valve.

They were then heated to a "black" heat, care being taken not to allow them to become even slightly red (as cast iron heated to a red heat does not contract to quite its original size upon cooling) and dropped onto the valve and allowed to cool slowly.

When cool, the valve was again placed in the lathe and turned down till it would just go into valve chest; then it was carefully brushed with a very fine file wherever it bore hard and was thus brought to a good working fit.

Then, from the marks made on the end of the valve, the line opposite the ports was redrawn on the bushings; using that as a center line, the paper template was wrapped around the valve with its ends equally distant from the center line and the ports scribed on the bushings, also the pinholes. This gave the location of the ports with a negligible error and as the

pinholes through the bushings were to be made large enough to prevent the pin touching them, the correction for these was easily made.

The ports were then cut through the bushings by first drilling small holes inside scribe marks and then finishing to old ports with small cold chisel and file.

Minor repairs, such as a new roll and stud for crosshead, etc., were also attended to and the main valve scraped to its seat and the pump reassembled.

Upon being connected up and valve motion adjusted, the operation of the pump was all that could be desired. Now while the time spent in doing this work was considerable, it did not in this case represent any additional expense to the plant but it did mean a great deal of experience and real knowledge to the engineer. As he expressed it, "I have got a good, reliable boiler feed equipment at small cost to the firm and a whole lot of experience for myself for a few days of very interesting work."

THE FUSIBLE PLUG

By Richard Haywarde

THE fusible plug is a safety device used in connection with steam boilers as a guard against negligence or accident. The function of the fusible plug is to melt when the water in the boiler becomes low enough to endanger the tubes or furnace plates, the melting of the metal permitting the escape of the water and the steam from the boiler into the furnace, thereby quenching or deadening the fire. The operation of the plug is dependent upon the heat which acts upon it; while it is covered with water, the heat acting upon it from the fire or the furnace gases is carried away by the circulation of the water, thus retaining the temperature of the plug below its melting point. But when it is uncovered the heat cannot be conducted away rapidly enough to keep the temperature of the plug below the melting point and consequently it is blown out.

Efficiency of the fusible plug has been the subject of much discussion as illustrated by the attitudes of the different states towards its use, some requiring it while others may make no mention of its use in their boiler practice regulation. The chief objection to the use of the plug is its uncertainty of operation which may be due to the following causes:

1. The nature of the fusible alloy changes. This is due to the various constituents of the feed water combined with the long exposure to heat changing the melting point of the metal and rendering the plug not to be depended upon.

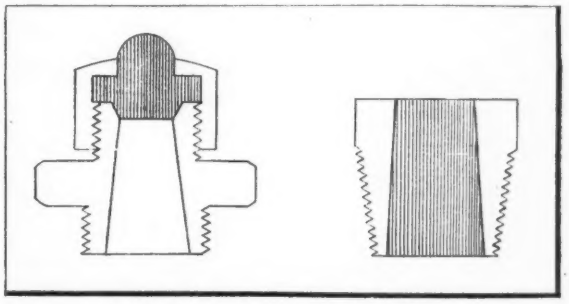
2. Scale prevents operation. Unless properly cared for and renewed, a hard scale forming over the plug results in its melting at the wrong time. If the alloy be covered with a hard scale the cooling action of the water is prevented and as a consequence the plug melts regardless of the position of the water. The accumulation of incrustation on the fusible metal may also be sufficient to withstand the steam pressure preventing the escape of the steam even after the plug has melted.

3. Difficulty in replacing. The melting of the plugs entails considerable bother to replace them.

A further objection is that ignorant firemen, rather than submit to censure for allowing the water to reach the danger mark, will drive in a steel plug or screw in an ordinary gas tap unknown to their superiors who are relying for protection on the supposedly present safety plug. Furthermore it is questionable whether the steam will be liberated rapidly enough to insure against overpressure after the plug has blown out and whether the escape of the dry steam will retard or tend to increase the rate of combustion dependent upon the position of the plug in the boiler.

The fusible metal may be composed of lead and tin, of bismuth and tin, or of like alloys, while as a matter of fact pure Banca tin, which melts at 445 deg. F., is most generally used. The plug has the form of the frustum of a cone, with the larger diameter on the inside of the shell to prevent its being blown out by the pressure of the steam. In practice the diameter varies from ⅜ to ½ in. as required. The melting point is determined by a temperature a little over that of the working pressure of the steam so that the fusible plug may also be regarded as a protection against over pressure. The quantity of the alloy bears a significant relation to the proper operation of the plug. If the quantity of the metal be too small, not a sufficient surface will be presented to the action of the heat, thereby reducing the efficiency.

The casing or bushing into which the fusible metal is inserted is constructed substantially of brass or bronze and of not less than ¾-in. pipe tap. Care should be exercised not to have the passage for the metal too restricted or confining so that all of the metal may be fused and blown out.



COMMON TYPES OF FUSIBLE PLUGS

The 2 most common types of fusible plugs are shown in the figure, being the internal and external types, although many other different constructions and departures are in use. The plug may be of annular shape, thus increasing the area in contact with the plates, a brass or copper center being inserted to take advantage of the heat by conduction. The alloy has been divided into several smaller plugs, thereby increasing the number of pieces to be depended upon for safety and making the plug more reliable in its action. In recent practice a device consisting of a pipe leading outside of the boiler and a warning whistle has been used with success. The pipe is led into the boiler and terminates at a point just above the tubes. A whistle surmounts the pipe and beneath it a fusible plug is introduced so that when the lower end of the pipe is uncovered by the water, the heat of the steam will melt the plug and the whistle will sound a warning. A globe valve is placed beneath the plug to facilitate renewal. Thus the objections of the internal plug are eliminated.

Fusible plugs should be placed at the lowest permissable water level, in the direct path of the products of combustion, and as near the primary combustion chamber as possible, and should project through the sheet not less than one inch.

Questions Answered and For Answer

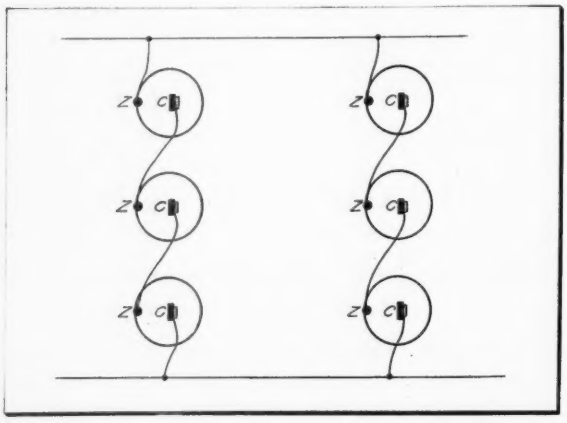
Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Setting; Transmission Problem

I AM installing a 72-in. by 16-ft. boiler. How often should the fire brick be tied into the wall? I mean how many rows of brick between the tie rows that hold the fire brick to the main wall? Should the side walls be built tight to the boiler or should there be a space left for expansion? The boiler is to be covered with brick. About what is the expansion of a boiler this size? Give a rough sketch of electric batteries in multiple series.

What size copper wire will it take to transmit 50 hp. 5000 ft. at 250 volts d.c. with a drop of 5 per cent? S. S. S.

A. The standard setting provides that the fire brick be fastened to the outside wall at every fifth course. The boiler should be covered in all places where hot gases come in contact with it above the water line. This, then, requires the brick to come



MULTIPLE SERIES CONNECTION OF ELECTRIC CELLS

in contact with the boiler, but only above the water line. Below that, you should allow a space of about 4 in. between the boiler and fire-brick lining.

The brickwork absorbs moisture and retains it, thus causing corrosion of the boiler plates. It is better, therefore, to fill the space between the boiler and the brick wall with fire clay or non-conductive covering. This is used to advantage as a boiler covering and beam about 2½ in. thick. It is lighter in weight and more effectually prevents the radiation of heat from the boiler than would an arch of fire-brick, as ordinarily constructed, over the top of the boiler.

Care should be taken in allowing spaces for expansion, especially around rivet heads, as a solid piece of masonry would crack or break off if a rivet head were securely plastered in the brickwork. The linear expansion in the boiler you mention would be about from 2½ to 3 in.

50 hp. = 50 × 746 watts, and that equals 37,300 watts (volts times amperes), 37,300 ÷ 250 volts = 149 amp.

The drop in the line is 5 per cent of 250 = 12.5 volts.

Resistance = e.m.f. divided by C, and that equals 12.5 ÷ 149 = 0.084 ohms.

$$R = \frac{KL}{d^2}$$

R = the resistance of wire in ohms;
K = the resistance of one mil foot in ohms;
L = total length of wire in feet;
d^2 = section area of wire in circular mils;
d = the diameter in mils.

Substituting in $R = \frac{KL}{d^2}$,

$$0.084 = \frac{11 \times (5000 \times 2)}{d^2}$$

d^2 = 1,309,560 circular mils;
d = 1143 mils, which equals 1.143 in.

In Practical Engineer of January 15, 1913, is an article on "The Calculation of Electric Circuits" which you might look up and compare with the work given.

The diagram for the multiple series connection of battery is given in the sketch. F. W. B.

Boiler Room Questions

WHAT is charcoal iron?

2. What is meant by the terms, tears, checks, snakes, slivers, laps, pits, rings and sink as they are used in relation to boiler tubes and flues?

3. How do you find the proper size condenser for an engine, jet and surface?

4. How do you find the proper size of air pump for an engine?

5. How do you find the proper size feed pump for a boiler? R. F. B.

A. Charcoal iron is made from pig iron which was smelted with charcoal fuel instead of coke, as is the practice in most of the blast furnaces at the present time. Only a small percentage of the iron product of today is charcoal.

2. These terms are not in common use and most of them have only a local meaning, as they are unknown in many boiler insurance and inspection companies' offices.

Probably a tear means a separation of the metal along a more or less regular line without any reduction in the thickness of the metal. Checks are incipient cracks extending only partially through the metal. A sliver is a small sharp splinter. The lap is the line along which the edges of the sheet are welded to form a tube. Snakes are forms of grooves, while sinks, pits and rings are the different forms in which corrosion occurs.

3. In a jet condenser it is not so much a question of size as of the capacity of the air pump. The air pump should be capable of handling 40 to 50 times the volume of the water condensed. In a surface condenser there should be from 1½ to 3 sq. ft. of cooling surface for each indicated horsepower of the engine, depending on the temperature of the cooling water and the vacuum desired.

4. The displacement of, or the volume swept through by the air pump piston should be 1/6 to 1/5 of the displacement of the steam piston when directly connected to the engine. If the air pump piston makes more or less strokes per minute than the piston of the engine, its diameter should be such as will produce a corresponding displacement.

4. In selecting a pump to deliver a given quantity of water per minute, there are 3 factors to be considered, the diameter of the piston, the number of strokes per minute and the length of stroke. Two of these factors must be assumed and from these the other may be found.

A boiler feed pump should be capable, while running at a fair speed, of delivering about 7 gal. of water per minute for each boiler horsepower. Then multiply the number of gallons to be delivered by 231, divide the product by the stroke of the piston in inches and divide this by the number of strokes per minute. Divide this by 0.7854 and extract the square root of the quotient for the diameter of the water piston.

F. L. Johnson.

Strain of Pins; Brush Resistance

WHICH has the more strain, the wristpin or the crankpin of an engine?

2. Which has the more resistance, a carbon or a graphite brush and when are they used? G. W.

A. The wristpin is subject to less strain than the crankpin, because the crankpin is overhung—that is, supported at only one end in most engines, while the wristpin is supported at both ends in the crosshead.

In a center crank engine, where the crankpin is supported at both ends, there is no difference in the strain.

On the matter of carbon and graphite brushes, the whole question was discussed in the article "The Use of Carbon Brushes," in the July 15 issue of Practical Engineer, page 694.

The carbon brush is harder and of higher resistance than the graphite brush. The graphite brush is used where a greater current density is desired, and a low contact resistance is necessary, such as high speed commutators for low voltage machines. A. L. R.

Injector and Engine Questions

GIVE the general description of the internal construction of an injector. Explain the reason why an injector will force water in the boilers from which it takes steam.

2. What part of an engine would you give most careful attention?

3. If a slide valve engine had 16-in. stroke, what should be the throw of the eccentric if outside lap is added, what further adjustment is necessary?

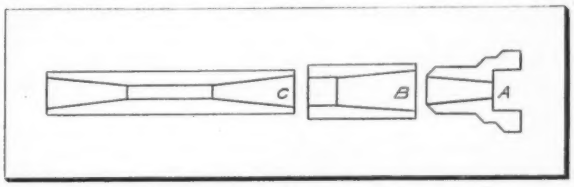
4. What do you understand by the term m.e.p., how do practical engineers determine if the engine performs its work economically? R. B.

A. The accompanying sketch shows diagrammatically the essential internal construction of the injector in which A is the steam jet, B the combining tube and C the water nozzle.

In operation the steam entering through A meets with the water at the mouth of the combining tube B, and is condensed, imparting a part of the velocity, which it acquired in condensing, to the water in the combining tube. This velocity is much greater than would obtain in a jet of water issuing from the boiler furnishing the steam, therefore the jet from the injector will overcome the pressure in the boiler and enter it.

2. All the working parts of an engine require intelligent care and frequent inspection, but the crosshead pin, because of the great pressure it sustains, the comparatively short travel of the moving parts and the danger of cutting if insufficiently lubricated, demands particular attention.

3. This question is incomplete as to the width of the steam ports and the amount of lap given to the valve. The steam ports should have an area equal to 1/10 the area of the piston and a length of about ¾ of the diameter of the cylinder. The area of a 16-in. cylinder is 201 sq. in. and 1/10 of 201 is approximately 20. To get the width of the port the area is divided by the length. The length is ¾ of 16 or 12 in.



CROSS SECTION OF AN INJECTOR

The width will then be $16/12 = 1\frac{1}{3}$ in. To give a full port opening, the valve must have a travel equal to twice the width of the port and the lap added together. If the valve has a lap of ⅔ in. the required travel will be $(1\frac{1}{3} + \frac{2}{3}) \times 2 = 4$ in.

Adjust the length of the valve stem so that the valve will travel equally both ways from its mid position and with the crank on the center turn the eccentric on the shaft in the direction the engine is to run until the valve has a lead of about 1/16 in.

4. M.e.p. is an abbreviation for the term "mean effective pressure," which, applied to steam engines, means the average pressure in the cylinder during the forward stroke minus the back pressure on the same side of the piston on the return stroke.

The economical performance of an engine is determined from analysis of indicator diagrams and comparison when possible of the work done with the weight of steam used. F. L. J.

Trouble with Safety Valve

I HAVE a 5-in. Crosby safety valve which I cannot get to pop. It has always worked until one day when it blew off it blew from 160 lb. back to 50 lb. Since then I have adjusted the ring and cleaned all the parts, as well as putting in a new valve stem and adjusting nut, and regrinding the valve. It acts just as it did at first, blowing back too far and starting to blow without popping, also closing slowly.

L. C. P., Asst. Ch. Engr.

A. The fact that your safety valve pops without warning and closes slowly, shows that there is a slight amount of friction in the mechanism some place that

assists the spring in resisting the pressure till the pressure has risen a small amount, possibly not over a pound, above that point where the valve would open were the valve in perfect working order.

On the valve proper, there are several wings, or guides, usually 4, which guide the valve, these guides working an easy fit in the lower part of the valve body. There may be a slight indenture or abrasion of these parts, which has been overlooked.

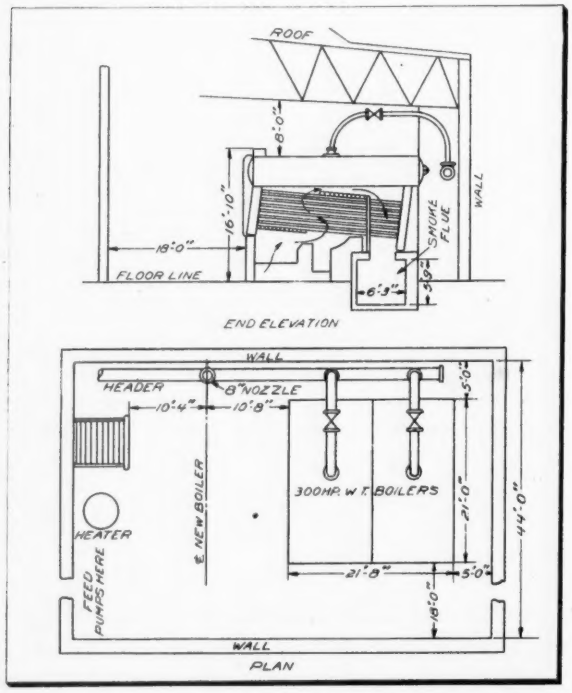
The Crosby valve has a device, for adjusting the "blow back" of the valve, the object of it being to make the escaping steam pass over a deflection edge where its reaction increases the pressure under the valve. This annular ring is adjustable from the outside and can be so set that it will catch under the edge of the valve as soon as it rises from the seat, and stays there till the pressure in the boiler is so far reduced that the extra tension of the spring closes the valve.

The blow back ought to be set so that the pressure will be reduced about 3 lb. below popping point, whenever the valve blows. If there is a lever for blowing the valve by hand, look over this as there may be some slight disarrangement that ought to be fixed.

G. H. Wallace.

Space for Boiler

IN space available indicated on sketch, it is desired to put in a water-tube boiler of as large capacity as there is room for, a Stirling being preferred. The breeching and chimney are of ample capacity.



PLAN AND ELEVATION OF BOILER ROOM TO SHOW AVAILABLE SPACE FOR NEW BOILER

Do you consider it practical to install a Stirling or any other 3-pass boiler, and if so, how would you lead the gases to breeching? What make would you advise me to recommend? What capacity? And what area would it cover?

Give all important points that should be brought out in a set of specifications for the boiler. K. F.

A. In the space shown in the sketch there is room for the installation of one Stirling boiler of 475 hp., or 2 of 200 hp. each. The floor space occupied will be 15 ft. wide by 17 ft. 9½ in. deep, and the height to the top of the steam outlet flange will be 21 ft.

The gases may be led to the underground flue by a suitable arrangement of the baffles in the last pass.

The contract should specify that the boiler shall be built according to Massachusetts standard.

While it is practicable to install a Stirling or any 3-pass boiler in the available space unless there is some good reason for not purchasing boilers of the make now in use, it would be good practice to have mechanical uniformity in all units of the same character. F. L. J.

Stoker for Anthracite Coal

I HAVE seen a great many styles of mechanical stokers in use, but I notice that soft or crushed coal is used. On inquiry I am told that hard coal cannot be fired with a stoker. Is this true? If so, will you kindly explain why this is so, and the difference in action of the kinds of coal? W. F. S.

A. There has been a large amount of experimentation covering both over-feed and under-feed stokers, in an effort to produce a successful mechanical stoker for burning anthracite coal and particularly for utilizing the enormous anthracite culm banks at the mines. Without any reference to economy or capacity, stokers of the inclined grate type have been used for burning anthracite, and quite a number of years ago a chain grate stoker was designed for this purpose and some of them were built. While fair results were obtained, they were not such as would warrant their extended application.

A consideration of first importance in attempting to burn clear anthracite coal or culm seems to be the necessity of depositing the fresh coal on top of the fuel bed, this calling for mechanism which will sprinkle the coal, mechanically, over the surface of the fuel bed, or hand firing. In any case an unusually strong draft is required. Forced draft is almost universally used. It has been found that anthracite clinkers badly and unless steam jets are used beneath the grate the life of the grate is short.

The difficulty of burning anthracite coal would be considerably reduced if it were commercially obtainable in a uniform size. Where the coal is of unequal sizes it permits of close packing on the grate, which greatly increases the air friction through the fuel bed and, since the fuel bed is not uniformly packed, it is difficult to maintain a uniform fire over the entire grate.

Coal, to be successfully handled with any mechanical stoker, should possess a high degree of ignitibility. Anthracite coal, since it contains a small percentage of volatile combustible, does not possess this readily inflammable nature, while bituminous coal does, owing to the much higher volatile content.

When bituminous coal is introduced into the fire box, it is at once heated to a high temperature and liberation of the volatile combustible commences immediately and the structure of the coal begins rapidly to disintegrate. These volatile gases are burned largely in the combustion space above the fire. Anthracite coal, containing as it does a small percentage of volatile combustible, necessitates the greater part of the combustion to take place on the surface of the pieces of coal, and thus the air for combustion must

be supplied uniformly to all the surfaces of the coal in order for proper combustion to be maintained. When air fails to get through any portion of the grate, due to clinkering or the presence of considerable fine coal, combustion at once falls off rapidly at that portion of the grate. This is not true to the same extent with bituminous coal, as the heat from the furnace breaks down its structure and even though a particular portion of the grate is not supplying the required amount of air for perfect combustion, the volatile gases are driven off into the combustion space above the fire and are there burned.

Anthracite coal or culm, when mixed with a liberal proportion of bituminous coal, can and is being successfully burned with mechanical stokers.

P. M. Chamberlain.

Trouble with Rites Governor

I AM experiencing trouble with a Rites governor which we have on an Ideal engine running at about 280 r.p.m. and direct connected to a 50-kw. d.c. generator.

Up to a few months ago, everything ran fine, but difficulties have come up which no amount of tinkering seems to remedy. The engine speed is all the way from 268 to 280 r.p.m. The following changes were tried:

The spring was fastened up some, but this only caused the engine to race. Then the block, which fastens the springs to the weight arm, was changed both forward and back; but this did not do any good, so the block was again changed back to its central position.

The hook fastening the spring to the weight arm was turned end for end. This seemed to help just a bit but not enough to remedy the worst trouble. Then we tried adding weights. First we added only 16 oz.; this did not give any radical changes, so we added 2½ lb. without any further changes. Nothing satisfactory was accomplished by this, so we tried tightening up on the spring. Even after all these changes the engine speed regulation seemed to be as sluggish as ever. Instead of keeping the voltage up to 220, it would drop to 210. Occasionally the voltage would be steady at 220 for possibly an hour, but then would fluctuate as usual between 220 and 210.

I really believe we have tried everything that we can think of. Possibly we are going at this in the wrong way—at least give us some of your advice on the proposition. B. F. W.

A. Judging by the description you have given of what you have done in attempting to solve the troubles with your Rites governor, it appears that the bulk of your trouble lies in the swivel bearing to one end of which is attached the eccentric, and to the other, the governor bar.

There may be other things which would assist in the trouble and these will be mentioned later on. The writer has had several experiences similar in many respects to yours, in one of which it was found that the inferior grease which had been used by the predecessor on the job, had so gummed up the several bearings that a valve stem was broken at the carrier arm. Previous to this, sluggish regulation was a growing nuisance and the entire governor was taken apart and the swivel bearing found to be so gummed up that the roller bearing could not work at all.

Some of the rollers were worn flat. New ones were made and when the governor was assembled and a superior grade of nonresinous grease used as a lubricant, normal conditions were restored and even overdone as the regulation was "boosted" as the load went up, about 2 volts.

Now, possibly this is your trouble. Adding weights ought to cut the speed down some, tightening the spring ought to raise it. Governor springs are of a given size for a given range of speed, and in case the speed desired is above the limit of the spring, one of a larger gage ought to be used.

The spring pin ought to be located about the middle of the slot in the governor arm, for while shifting it in or out will change the speed, yet the function of the slot is to obtain the right amount of sensitiveness, some engines requiring a little different location from others of identically the same size, in order to obtain the proper sensitiveness.

The principal thing to secure regulation with any kind of shaft governor is to eliminate as much friction as possible in the governor, eccentric and valve. A sprung stem, hard packing, poor lubrication, both in the steam chest and on the eccentric and valve stem guide, all help along, in causing the trouble you are experiencing.

Occasional shots of wet or dirty steam, if there is no reliable way to remove these annoyances, will produce additional friction on the valve which reflects on the governor regulation. Does your boiler foam or prime?

Look over all the things that have been mentioned above, and after assembling the governor, remove all weights that you have added (these engines are all tested by the builders and the proper weight applied to the governor), see that the spring pull block works free on the pin (it ought to work on a case hardened knife edge by rights), and is free from strains where attached to the rim of wheel, and then draw up on spring till the proper speed is obtained. Use good oil all over. It pays. Take some cards of the engine and see if your valves need looking after. They sometimes do. G. H. Wallace.

Live and Exhaust Steam

WHAT is the difference in heating value of live and exhaust steam? For example, suppose we carry 100 lb. pressure on our heating system, and we wish to use the same amount of live steam through a reducing valve, is there any difference in the heating value, and, if so, how much? This does not include the lost heat of the radiation in the cylinder.

H. G. R.

A. A certain quantity of steam at 100 lb. boiler pressure would have, after running through a reducing valve, all of the heat in it which it had in the beginning, with the exception of the radiation on the way from the boiler to the place where it was used. If steam at 100 lb. pressure, or any other pressure, is reduced through a reducing valve, it has the same total heat after being reduced as it has at the original pressure. If the initial steam at 100 lb. is dry, the steam, after going through the reducing valve, will be superheated some; if the initial steam is slightly moist, the extra heat will be used to dry out the steam after passing through the valve, and it will not be superheated so much. The reason for this is, that there is no work taken out of the steam with the exception of that which causes the steam to rush through the valve with high velocity, and that is all given back to the steam in the form of heat.

Now, when steam passes through an engine doing work, the case is different. A theoretically perfect

steam engine taking steam at 100 lb. gage and exhausting into the atmosphere has a thermal efficiency of about 15 per cent. That means that 15 per cent of the heat in the steam is gone out of the steam into external work in passing through the engine. Of course, no engine is theoretically perfect, so that we can reduce our figure to about 12 per cent for a good engine, and 100 — 12 = 88 per cent of the heat will be remaining in the exhaust of the engine as against all of it remaining when it passed through a reducing valve.

That is, as stated in the question, neglecting radiation. S. E. Balcom.

Adjusting the Governor; Equalizer on Suspended Boiler

IF you loosen one governor rod and tighten the other on a Corliss engine, what will be the effect?

2. What is an equalizer used where 3 supports are used on each side of the horizontal tubular boiler? Give a description of an equalizer. S. J. S.

A. The effect of loosening or tightening the governor connections on a Corliss engine, on the engine as a whole, depends altogether on the design, as there are many methods among the numerous Corliss engine builders, of transmitting the action of the governor to the knockoff cams.

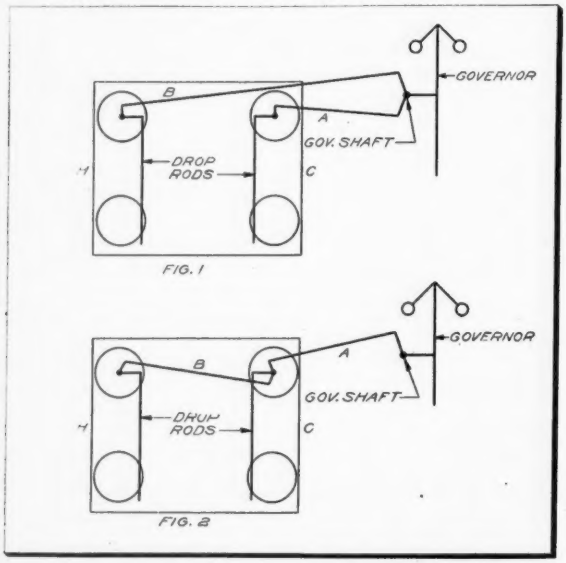


FIG. 1. GOVERNOR WITH 2 RODS TO VALVES
FIG. 2. GOVERNOR WITH ONE ROD TO VALVE

The 2 principal types, however, most commonly used are those shown in the accompanying sketches. In Fig. 1 the knockoff cams are both operated from the governor shaft by the 2 arms, as shown. If the rod A be lengthened and the rod B be shortened, each an equal amount, the only effect will be to cause the engine to operate at a slightly greater speed in order that the rotating parts of the governor may assume a slightly higher plane of rotation, thus bringing the knockoff cams into the same identical position as before the change, load and steam pressure being the same.

If both rods are lengthened or shortened, the effect is to change the load between the 2 ends of the cylinder, as the point of cutoff will be changed.

Referring to Fig. 2, there is but one connection between the governor shaft and the forward knockoff cam as indicated by the line A. From the bottom of the forward cam is another connection for the rod B which runs back and operates the knockoff cam at the other valve.

If the rod A be either loosened or tightened, it will not change the relative points of cutoff between the 2 valves, but the speed of the engine will be affected slightly, depending on which way the rod is adjusted.

But if you adjust rod B it changes the point of cutoff at the head end only, and if you want to change the point of cutoff at the crank end and still retain the same plane of rotation of the governor, it will be necessary to make the same adjustment with each rod; that is, either lengthen or shorten both.

You should not change the governor rods at any time until you have studied the case well, and have decided just what to do and what adjustments to make in order to accomplish certain results.

2. An equalizer is used on a 3-point suspension boiler for the purpose of equalizing the strain between all of the supports at all times in order to overcome the difference in temperature and consequent difference in expansion and contraction in the boiler which is ever present. Otherwise owing to, say, feeding cold feed water into the boiler at the back end, the tendency would be to shorten the bottom of the shell a small amount which would cause the middle of it to rise slightly.

So, if under these conditions each of the 3 side supports should have its own supporting device, the middle support would have no load and the entire weight of the boiler and contents would be supported by the 2 end devices, thus setting up severe strains in the boiler, which must be avoided entirely if possible.

This device is used almost exclusively on the larger types of boilers, which almost without exception, are suspended by suitable links or bolts, from a steel framework. To all intents and purposes, an equalizer is almost precisely the same thing as an "evener," such as is used to equalize the load between 2 horses on a wagon.

The 2 ends of this evener are attached to 2 side supports by suitable links or bolts, and from the middle, another such link or bolt is erected to meet the supporting framework.

Three-wheeled passenger trucks, and all locomotives use the same method of equalizing the load of the boiler, etc., between the several pairs of wheels, and when such an engine has 4, 5, or even 6 sets of drivers, the equalizing device is a complicated affair, indeed, and one that requires careful study in order to work properly. G. H. Wallace.

Ice Making Problems

HOW would you pump out any kind of ice machine? What is the head pressure and what is it for? Where does the ammonia first start to cool?

P. M.

A. If it is your desire to remove all ammonia from a system, when you say pump out any kind of an ice machine, the first thing necessary would be to secure enough empty ammonia drums to hold the entire charge of ammonia. Then, to remove ammonia from entire system, you should close the king or main liquid valve on ammonia line leaving the receiver. Then attach an empty drum to the valve on the bottom of receiver which is placed there for that purpose. After connections have been made, valves

on the receiver and drum should both be opened, when the ammonia will pass from receiver to drum. Care must be taken not to fill drums too full. Never put more ammonia in drums than they originally contained, as room must be allowed for expansion.

After starting to remove ammonia, the engine may be started and run slowly so as to remove all liquid ammonia that may be in the refrigerator. At the same time you should have the cold water pump running, so as to keep the condenser as cool as possible. When all liquid is removed, the purge valve may be opened, allowing all noncondensible gases to escape to atmosphere.

The term pumping out is often used in the engine room to mean merely to remove the ammonia from the refrigerator before closing down, and all that is necessary in this case would be to close the king valve on liquid receiver or the expansion valves at the refrigerator. Pumping out is also used when it is necessary to remove the ammonia from some part of the system for making repairs. Every plant is supposed to be equipped with the necessary by-pass lines whereby any part of the entire system may be emptied or pumped out, so that any needed repairs might be made. Should you desire only to stop engine for a time it would only be necessary to pump down to zero on low-pressure gage, but if you desire to make repairs you should pump a vacuum of 15 to 20 in.

The term head pressure applies to the condensing pressure, and is the pressure required under a certain temperature to liquefy ammonia gas. This pressure depends entirely upon the temperature and quantity of water supplied to ammonia condenser.

The ammonia first starts to cool, or remove, or absorb heat, after passing through the expansion valve. This valve is usually located at or near the refrigerator, and is used to regulate the flow of ammonia into the refrigerator. Here, also, the ammonia pressure is reduced from condensing pressure to the pressure carried on the refrigerator. W. H. Biesley.

Air Required for Hoist

HOW do you figure amount of free air necessary to run a hoist: 10 by 12 in., double cylinder geared mine hoist; 450 ft. per minute rope speed; 41 in. diameter drum, 58 in. diameter gear, 12 in. diameter pinion; steam inlet pipe 2½ in., ¾ cutoff, about 5 per cent clearance; load about 5000 lb; compressed air to be used at 90 lb. pressure? Subscriber.

A. In computing a problem of this kind, we are assuming that the air is admitted to the cylinders with a pressure of 90 lb. at the throttle, and that there is no back pressure. We are also adding 20 per cent for friction of the engine and gears.

It is first necessary to find out how much work is done, in foot pounds and work backwards, so to speak, to the engine, and the following data will explain the various steps taken to secure the amount of free air required per minute as a motive power to perform this work:

Lift of 450 ft. p.m. × 5000 lb. load = 2,250,000 ft. lb.

2,250,000 ÷ 33,000 = 65 hp.

Add 20 per cent for friction = 78 hp.

Radius of drum, 20.5 in. Radius of gear, 29 in.

Circumference of drum = 10.5 ft.

450 ft. ÷ 10.5 = 42.8, which is r.p.m. of drum and also of the 58 in. gear on the same shaft.

Ratio of gear to pinion = 1 to 4.83.

42.8 × 4.83 = 206.7 = r.p.m. of pinion on engine shaft and also of the engine.

With 12-in. stroke, piston speed is 413.5 ft. p.m.

Area of 10-in. piston is 78 sq. in.

Then the m.e.p. will be 78 divided by $\frac{413.4 \times 78}{33{,}000}$ which equals 90 lb. m.e.p. if all work is done in one cylinder.

90 ÷ 2 = 45, which is m.e.p. in each cylinder.

Total cylinder volume = 78 × 12 = 936 cu. in.

5 per cent of 936 = 47 cu. in. = clearance at each end.

With 2/3 cutoff, there are 702 cu. in. in cylinder when cutoff takes place.

Add to this 47 cu. in. in clearance = 749 cu. in. of air at 90 lb. pressure in cylinder at point of cutoff.

90 lb. equals 5 atmospheres.

Then 749 × 5 = 3745 cu. in., or 2.11 cu. ft. of free air used up to point of cutoff, at each end of each cylinder.

2.11 × 4 = 8.44 cu. ft. of free air used per revolution of engine.

8.44 × 206.7 = 1744.548, which is the cubic feet of free air per. min. the engine will use under the load conditions as stated. G. H. Wallace.

Comparative Values of Coal and Shavings

IN reply to the question of E. K., in the Sept. 1 issue, as to whether coal at $2.60 a ton or sawdust and shavings at $1.00 a ton would be the cheaper, Hocking Valley coal has a proximate analysis of volatile matter, 32.85 per cent; fixed carbon, 48.74 per cent; moisture, 6.51 per cent; ash, 8.93 per cent; sulphur, 1.58 per cent, and an approximate calorific value per pound of combustible of 14,080 B.t.u. This is for an average sample of mine run. Screenings and slack would show a higher percentage of ash, as it would include more slate and mine dirt, and the ash, moisture and sulphur would probably equal 20 per cent, leaving a calorific value of 14,080 × 0.80 = 11,264 B.t.u. per pound of coal as fired. At a cost of $2.60 a ton of 2000 lb., the cost per million B.t.u. would be

$$\frac{1{,}000{,}000 \times \$2.60}{11{,}264 \times 2000} = \$1.155 \text{ per million B.t.u.}$$

The calorific value in B.t.u. per pound of dry wood is 9150 for pine, and 8310 for oak. As the shavings are part hard and part soft wood, the calorific value would be about 8700 B.t.u. per pound of dry wood; but ordinary wood contains about 20 to 25 per cent moisture and 1 per cent ash, therefore the calorific value would be 8700 × 0.75 = 6525 B.t.u. per pound as fired, and the cost per million B.t.u. would be

$$\frac{1{,}000{,}000 \times \$1.00}{6525 \times 2000} = \$0.83 \text{ per million B.t.u. as compared with } \$1.15 \text{ for coal.}$$

This shows that shavings and sawdust would cost less for a given number of heat units than screenings. This $1.00 per ton for shavings does not cover the cost of handling, and a great deal more storage space would be required, the value of which can only be determined by the conditions of the plant in question. As his is a woodworking plant using shavings and sawdust at present, his boilers are probably arranged for that kind of firing, therefore I think that the 32½c per million B.t.u. difference in price would be largely a clear saving in favor of sawdust and shavings.

J. C. Hawkins.

PRACTICAL
ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyrighted, 1913, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 22,500.

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FIRE POWER vs. WATER POWER

In the mythology of the ancients, fire and water were represented by 2 gods who were always struggling for the mastery waging unceasing warfare on each other and in the course of their struggle, working great hardship to the human race. With the growth to a more practical age, both fire and water have been reduced to the position of servants of men, but both are still cruel when they break their bounds. With the increasing demand for the use of power in daily life, for light, for cooking and heating, for refrigeration, for transportation, for small and large power units, both localized and distributed, the call for power supply increases rapidly, and the problem of meeting this demand is becoming a serious one.

Three natural sources of power are available, fire, water and wind, but the last named is so uncertain and unsteady that it has not been possible to utilize it to any great extent. Fire, in any of the forms in which it is used has the advantage of reducing stored energy beyond recall, whether we burn wood or coal in a boiler, or gasoline or crude oil in an engine. Power from water, on the other hand is perpetually renewed but is never stored by nature, and if we are to seize the energy developed by the streams and tides, we must do it as it passes by. Leaving out the waves, which, so far, we have not been able to harness, it is estimated by Morris Knowles, in a paper in the Electric Journal, that some 37,000,000 of horsepower is commercially available for development in this country, while the ultimate capacity of the streams is about 230,000,000 hp.

One great drawback in the development of many streams is the unreliability of the supply. Prof. P. M. Lincoln has pointed out that, if it is necessary to erect a steam plant to supplement the water power plant, it is hardly ever a good investment to pay the cost of both water and steam plants. It is therefore necessary that we should have stored a supply of water which will guarantee a constant power the year around for industrial purposes. In some places this storage can be accomplished at the point where the hydraulic development is installed, but in more cases it is impossible, either because the storage basin is not available at that point, or because the value of land is too great. It is therefore necessary to control the flow at the head waters and this means a great undertaking at a point remote from those who will benefit by the power to be supplied. Such control at the head waters is a conserving, not only of power, but of life and property as well, since it will be a means of preventing the periodic floods which are such a menace in the lower river valleys.

Some cases are extremely difficult, as, for instance, those in Ohio during the last summer. The floods were due to very unusual rains, and there is not availble, in the region where these rains fell, mountain basins sufficient for storage, nor is the frequency of floods sufficient to warrant such storage. On the other hand,

such rivers as the Ohio, the Missouri and the Mississippi, which every year are productive of great damage, can readily be controlled at the head waters, but of course at a large expense. As against this cost of control, however, there is to be balanced the saving in fuels to develop the same power by fire, which will leave the fuel for use in localities where water power is not available; we shall also be saving a great annual destruction of life and property, and by properly using our storage reservoirs, we can accomplish the irrigation of great tracts of land which otherwise will be unproductive.

Another angle to this whole question is that of drainage projects for unwatering land at present covered in the river basins. By restricted storage reservoirs into which these waters are led, it will be possible not only to make available a great area of rich land for agricultural purposes, but also the reservoirs may be made to yield a large amount of power at low head.

The whole question of developing water powers as rapidly as possible, in order to grasp the power which is now running to waste and to save that which will remain stored as fuel if we do not consume it, calls for a big, broad-gage policy, big expenditure and far sight into the future; but such a policy will pay large in the returns of developed waterpower, increased food resources and preservation of heat power stores. It calls for national and state action and co-operation and for the best engineering skill which the country affords.

TO PATCH A CONCRETE FLOOR

Cleaning the Hole, Consistency of Mortar, Setting

WHEN a cement floor surface begins to wear it is often desirable to patch it. Leonard C. Wason, president of the Aberthaw Construction Co., Boston, in a recent paper states the right way.

Cut down the worn place at least 1½ in. This cutting should be carried into the strong, unbroken concrete and the edges should be cleanly undercut. The bottom of the cut should then be swept out, clean-blown out with compressed air or a pair of bellows, if available, then thoroughly wet and scrubbed with a broom. In this way small, loose particles of broken material which the chisel has driven into the surface are removed. A grout made of pure cement and water about the consistency of thin cream, should be scrubbed into the pores with a broom or brush, both at the bottom and sides of the cut. Following this, a stiffer grout, about the consistency of soft putty, should be thoroughly compressed and worked into the surface, which has already been spread with grout. Finally, before the grout is set, a mortar made of one part cement to one part crushed stone or gravel, consisting of graded sizes from ½-in. down to the smallest, excluding dust, should be thoroughly mixed and put in place, then floated to a proper surface. Cover with wet bagging, wet sand, sawdust, or other available material. All trucking should be kept off and the surface kept thoroughly wet for at least 1 week or 10 days.

If a particularly hard surface is required, 6-penny nails are sometimes mixed with the mortar and other nails stuck into the surface when the patch is finished. This will produce a surface which is extremely hard and durable.

QUALITY OF WATER IMPORTANT

Impure or Highly Mineralized Waters Sometimes Cause Heavy Money Losses

THE quantity of water used in modern human industry is so vast, its applications are so varied, and its essential characteristics are so distinctive that water may be considered the most important mineral used in the industrial arts. Immense quantities of water are necessary for many manufacturing operations. Every pound of writing paper made. for instance, has required the use of not less than 40 lb. of water, and in some paper mills as much as 1600 lb.

The quality of the water used in the steam boiler is of interest to the engineer because upon it the profitable production of steam in large measure depends. The life of the boiler also is in no small degree determined by the care taken to supply it with proper feed water. With a noncorrosive water which does not form hard scale a stationary boiler may last 30 to 35 yr., but a corrosive water may make it useless in 5 yr.

Many waters, especially spring waters, that are comparatively free from mineral matter in solution are known to be strongly corrosive when used in steam boilers. Free acids, such as hydrochloric, sulphuric and nitric, are corrosive, attacking iron easily, and waters containing them must therefore be neutralized before they can safely be used for steam making. Water showing no sign of acidity before it enters the boiler sometimes develops corrosive properties when it is heated. Water containing magnesium chloride in solution, for instance, may be neutral under ordinary conditions, but at high temperatures and under increased pressure of the boiler hydrolysis occurs, forming free hydrochloric acid, which vigorously attacks the boiler shell and tubes. The scale from calcic carbonate waters is loose and can be removed by blowing off. Calcic sulphate waters, on the other hand, form a hard tenacious scale, the removal of which is sometimes difficult. Hard scale conducts heat poorly. A waste of 15 to 20 per cent of fuel has been known to be caused by hard scale only 7 to 8 mm. thick. Boilers thus overheated are liable to blister and to crack, and many serious explosions have resulted from overheating scale-lined boilers.

Salutary Effect of Scale

THOUGH a thick, hard scale is detrimental to a boiler, a thin coating of scale is often distinctly advantageous. This is especially noticeable where corrosive waters are used for making steam. Rain water and even melted snow cause pitting of the plates and more or less general corrosion. As a protection against the ravages of waters of this kind the occasional addition of a little limewater is recommended, so that a thin coating of scale may be formed.

Many specifics for preventing and removing boiler scale are on the market, some of them being helpful but others of little value, though the vendors use persuasive arguments in presenting the merits of their wares. Care should be exercised, however, not to use the wrong kind of boiler compound, as more harm may be caused by it than by the untreated water itself. (From Water-Supply Paper 233, United States Geological Survey.)

REAL PERSONAL EFFICIENCY is to save time and then use it to good advantage.—System.

Announcing the January 1, 19

OLD subscribers, new subscribers and engineers who have acquaintance with Practical Engineer Specialized Numbers will be interested in the following:

The January, 1914, Power Plant Efficiency Number will be the most valuable power plant publication ever offered to engineers.

Manufacturing power in a power plant is no different from manufacturing any other product in a properly equipped factory except that the machinery used is more diverse and complex and the ability required to handle it is greater than for any other class of manufacturing machinery. All the same elements enter into the manufacture of power that come into any other work; raw material, equipment, methods and labor. For the best results each element must be properly fitted to its purpose and all processes must be so related as to eliminate waste and losses to the greatest possible extent.

Selection of Materials

TAKING up these elements in their order, we shall come first to raw materials, which consist of fuel, water and lubricant. Evidently each of these should be obtained of the kind best fitted for the use to which it is to be put, the same as would be the case in buying iron to make boilers or leather to make belts. For fuels; their composition, heat value and impurities must be determined; the effects on the furnace and heating surfaces, etc. In the case of water; impurities contained and what temperature will be most suitable for the supply. And lubricants; their qualities and characteristics and whether they contain impurities that will be detrimental to boxes and shafts.

With respect to equipment; this important element in production will be considered—the bearing each piece has to the whole, its proper installation, capacity, type and location.

Upon this head will be considered various methods of handling poor fuel, the effect of bad furnace conditions, poor draft, insufficient heating surface, air leaks, pressure drop, radiation, valve and join leaks, high back pressure, wet steam, exhaust waste, friction, resistance loss, and hundreds of causes that may destroy the profitableness of your plant.

Then there are the transformations to be made in changing the stored energy of the fuel to the applied power and how the equipment of such transformation required will be made most effective. The furnace must be designed of proportions best to absorb and transmit heat; the boiler to transmit the heat to the steam rapidly and effectively; the piping to convey the steam or other fluids with the smallest loss of pressure and heat to the point where the second transformation is to take place, and the prime mover must be fitted to effect this second transformation with a minimum of waste. Belts or wiring should then convey the power with the least possible loss to the point where it is to be applied in useful work. All these problems involve the study of equipment to be used, the methods of using it and precautions for insuring that there shall be no falling off in efficiency.

Testing and Testing Instruments

DESCRIPTIONS and methods of using the various kinds of test apparatus, draft gages, pyrometers, thermometers, pressure gages, gas analysis, steam engine indicators, calorimeters, voltmeters, etc., will be outlined with complete details where such are necessary.

In order to better the performance of a plant it is necessary to know in detail what it is doing and how that performance compares with the possibilities. For this purpose records must be kept and comparisons made with other plants. Tests of individual pieces of apparatus such as furnaces, boilers, pumps, piping, prime movers, generators, transmission apparatus for efficiency should be part of the regular routine and a continuous hunt for losses should be a part of the operating game.

Points where losses are likely to be found or to develop will be indicated and how to test out at such points to find whether best possible results are being obtained and maintained.

1914, Efficiency Number

Power Plant Records

TO compare the performance of the plant from time to time with the performance of other plants, it is necessary to have the data from tests properly and systematically recorded and reduced to a common basis, and the question of records will be fully gone into, and records that have been found satisfactory in actual use will be shown, and just how to keep them will be fully explained. Also, forms of records will be suggested to fit different kinds of power plants and the methods of deriving results from the data and of making comparisons both analytically and graphically will be given. These records will show not only the results of testing for efficiency, but will be arranged to show the expense of operation of the plant for the different items of raw materials, wear and repair of equipment, labor and supplies, and the method of distributing these items of expense properly against the useful power supplied for various purposes.

Systematizing Labor

THE need of regular systematic work is emphasized at every point and at no part of the operation is this greater than in the control of the labor in the plant, not only in the matter of testing, but in the regular daily routine for starting, stopping, boiler firing, wiping, cleaning up, in fact, in every part of the work there must be system and regularity to get best results.

This issue will show proper assignment of daily and weekly work and suggest methods for the training of men for better positions, etc. The chief must know the results of operation and how things are going in each part of the plant, involving a careful inspection; he should be in close touch with the men, demand full detailed reports and records from every department. Systems of reporting various conditions in the plant will be shown and various methods of inspection will be suggested.

Cost Finding Is The Key to Efficiency

IN any industrial operation the results are measured in terms of dollars and cents and so in the measuring up of performance of the power plant, the cost to produce the unit of power delivered is the final measure of its effectiveness. The unit may be a kilowatt hour of electrical energy, a ton of ice or of refrigeration delivered, a square foot of heating surface for radiation supplied or a cubic foot of room heated or a cubic foot of compressed air supplied. In any case, to judge rightly the performance of a plant there must be some standard by which to measure it. Reasonable standards of performance for different kinds of power plant operation will therefore be an important feature of the issue, and it will be shown just how to reduce records obtained from test and measurement to terms of cost of power delivered so that the actual cost can be compared with the standards as given.

Men who have made this a business for years will contribute their instruction as to what they have found to be the best methods for careful study of actual conditions and for introducing such changes as may be found desirable in the way of equipment, arrangement and operating methods.

A Text Book of Efficiency

IT will be seen that the issue will be a complete text book on power plant efficiency, starting from the fundamental consideration of what elements must go toward making efficiency, giving each detail to be considered in order to secure the necessary knowledge of present performance, how to determine possible performance and how to bring these two closer together.

If success counts with you, this issue will be a necessity.

This big special Efficiency Number is a part of a regular subscription—there are twenty-three other issues that will be of the greatest possible value to power plant men and one dollar pays for them all.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

NEW TERRY CONDENSING TURBINE

Reversed Flow of Steam in Low-Pressure Element Overcomes Air Leakage

TWO main objects were before the engineers in their design of the latest type of Terry condensing turbine. They were after an economy approaching that of the larger units used in power installations; they aimed to overcome the old trouble of air leakage into the condenser.

This air leakage has been completely overcome. The only gland exposed to vacuum has been shifted from the end of the casing, as in other types of condensing turbines, to the middle, where it is exposed on one side to vacuum and on the other to steam at just above atmospheric pressure. This makes the leakage of air through this gland a physical impossibility.

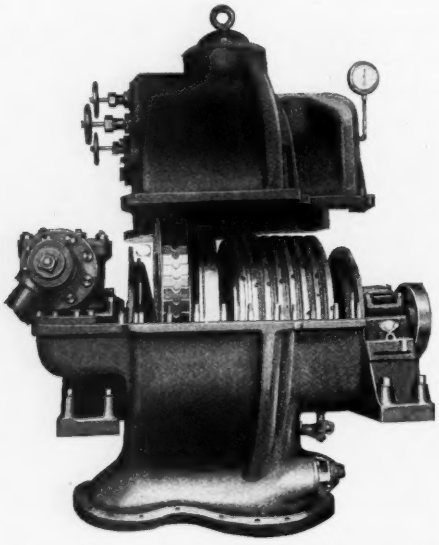


FIG. 1. TERRY TURBINE WITH COVER RAISED

The machine consists essentially of a regular Terry multi-velocity wheel as the high-pressure element and a low-pressure end consisting of several multi-pressure impulse elements. The main feature distinguishing the arrangement of this low-pressure element lies in the fact that it has been turned end for end, receiving steam at the end farthest from the high-pressure element and exhausting into the condenser connection at the center of the turbine. By this simple device of reversing the flow of steam and thus protecting the vacuum gland, the old trouble of air leakage has been eliminated.

This turbine has the regular Terry characteristics, including casing split on the axial plane, permitting examination of the runner without disturbing steam or exhaust connections. It has the Terry indestructible high-pressure element which permits starting up the turbine from cold, even though a large quantity of water is thus thrown through the blades. This is done regularly, without any danger from water hammer or any apprehension as to stripping of blades.

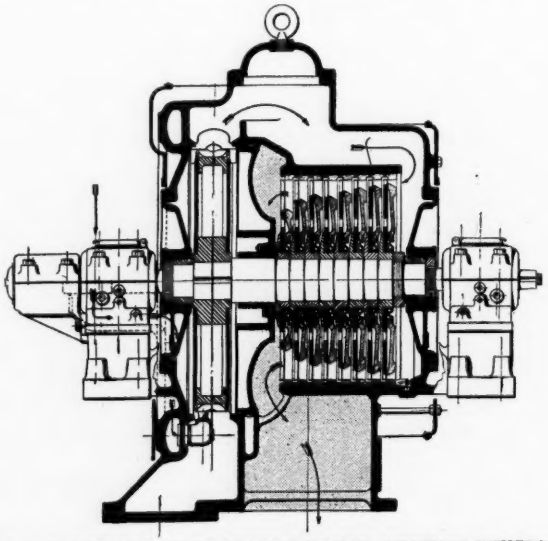


FIG. 2. CROSS-SECTION OF TERRY TURBINE, SHOWING REVERSE FLOW OF STEAM

The stationary buckets in the low-pressure end are placed on annular rings, from which they may be removed in blocks as necessary. These rings are not fastened to the casing, but are bolted together and remain with the runner when the casing is removed,

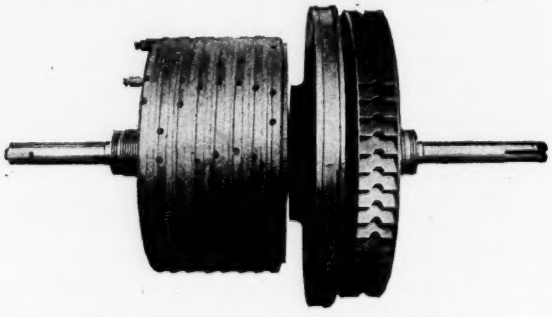


FIG. 3. RUNNER OF NEW TERRY TURBINE

as will be noted in the illustration. They are held by friction to the casing when the upper half is drawn down tight to the lower half, and hence always retain their position when the turbine is running. This arrangement makes it simple to examine all parts with a minimum of trouble.

The method of swinging the casing from the bearing blocks instead of from the base, makes it always concentric with the runner. Expansion is radial and all clearances are maintained practically the same when the turbine is running as when it is cold. The side of the bearing in the pillow block is cylindrical. This is bored at the same time as the casing and from the same center. It follows, therefore, that under no circumstances can the axis of the runner get out of line with the axle of the casing.

This new design of turbine is being applied to 3-principal uses: driving electric generators, blowers and centrifugal pumps.

THE STURTEVANT AIRWASHER

New Type of Nozzle Forms a Rain Spray and Horizontal Eliminators Remove Water from Air

THE new Sturtevant airwasher, whose external appearance may be judged from Fig. 1, is of the rain spray type with horizontal eliminators. It consists of 3 parts, the spray chamber, in which the washing actually occurs; the eliminators, which remove all entrained moisture from the air and the sump, or tank, which forms the bottom of the airwasher, and into which falls all of the water from the spray pipes, and the eliminators. In Fig. 1 can be seen the eliminators, the spray chamber, and the sump. Besides these parts, there is necessary a recirculating pump for creating a circulation of water in the spray pipes.

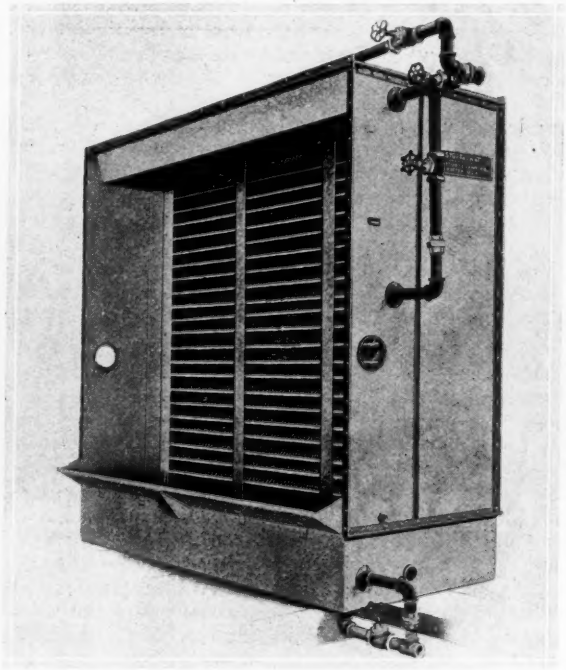


FIG. 1. THE STURTEVANT AIRWASHER

When installed in a ventilating system, the arrangement shown in Fig. 2 is used. Here it will be seen that the air enters at the left, passes through a tempering coil and heater into the airwasher, and thence through a second heater into the fan. The pump and water piping are shown in this drawing and a portion of the casing has been broken away in order to show the eliminators of the airwasher.

To form the rain-like spray in the Sturtevant airwasher the nozzle shown in Fig. 3 is used, being attached to the spray pipes in the spray chamber. The design of these nozzles is unique and permits of a large orifice so necessary to prevent clogging. The water issuing from the orifice under pressure created by the recirculating pump, strikes against a lip curved over this orifice and is broken into a spray, spreading out broadly, due to the shape of the lip and thus filling the chamber completely. The water falls into the sump below. The spray chamber is constructed of galvanized steel and the interior is painted with black asphaltum.

Air passing through this rain-like spray is cleansed of every particle of dirt and impurity and finally comes in contact with the eliminators, whose position in the airwasher can be seen in Fig. 1, which are placed horizontally across the airwasher and form between them, broken passages through which the air must pass in order to leave the spray chamber. The surface of each of the eliminators is perforated in

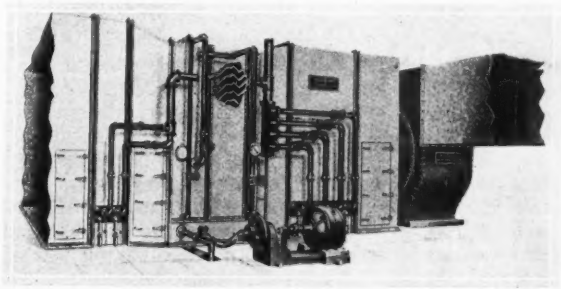


FIG. 2. TYPICAL ARRANGEMENT, STURTEVANT AIRWASHER, SHOWING TEMPERING COILS HEATER AND MULTIVANE FAN

such a way that small lips of metal are formed and the edge of each eliminator is serrated. The air laden with moisture strikes against the edges of these serrations and perforations and against the edges of the metal lips, where the entrained moisture is removed so that when it leaves the eliminators, the air contains no unevaporated moisture. The water dripping from these eliminators further increases the efficiency of the washing process and drains into the sump below. The eliminators are constructed of galvanized steel, and are painted with black asphaltum.

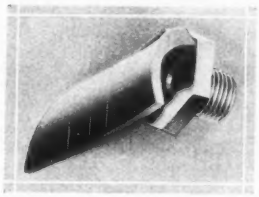


FIG. 3. NOZZLE, STURTEVANT AIRWASHER

The sump, which may be constructed of galvanized iron or of concrete, is a tank into which the water falls from the spray chamber and eliminators. It is provided with an overflow which maintains a constant level of water within and with a drain and strainer. A flat valve maintains the water supply.

Water is drawn from the sump by a small centrifugal pump shown in Fig. 2, and is delivered to

the spray pipes under sufficient head to create the desired spray. The pump suction pipe draws the water within the 2 screens. As the orifices of the nozzles are comparatively large, the mesh of the strainer is not so fine that excessive power is required to drive the pump, and as a second wire strainer in the washer pipe is unnecessary, another saving in power for the pump is thereby effected.

This airwasher is the product of the B. F. Sturtevant Co., Hyde Park, Mass.

KROESCHELL COMBINATION BOILER

Addition of Water Tubes to Return-Tubular Boiler Increases Efficiency and Cuts Down Space; Flume in Boiler Aids Circulation

CONSTRUCTION of this boiler is shown by the longitudinal section in Fig. 1. It consists of an ordinary return-tubular boiler to which are attached 2 headers or water legs that are connected by 3 or 4 rows of tubes, the number depending upon the size of boiler. It will be noted that the front header is attached to the shell by means of a 10-in. horizontal connection, and that a flume, represented by the heavy dotted line, is placed near the bottom and extends back about 2/3 the length of the boiler. The purpose of such a construction is to cause the water to flow with a high velocity above and below the flume, thus preventing the deposit of scale forming material on the shell and tubes by carrying it back into the sediment chamber in the rear water leg, from which it may readily be blown out through a blowoff cock.

Furnace baffling is so arranged that the hot gases, whose path is indicated by the arrows, instead of coming directly in contact with the cold surfaces of the tubes, are carried back to the rear, where they pass up between the water tubes and along under the shell to the front of the

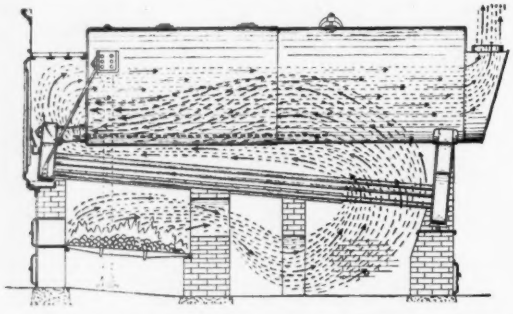


FIG. 1. LONGITUDINAL SECTION OF KROESCHELL COMBINATION WATER-TUBE AND FIRE-TUBE BOILER

boiler, returning through the fire tubes and passing out of the smoke box at the rear. Not only is this arrangement a great aid to combustion, but it removes the lower half of the shell from the impinging heat of the fire, and by preventing unequal expansion and contraction between tubes and shell, it avoids any leakage of tubes. The fact that the temperature of the gases is not materially lowered by contact with cold surfaces until they reach the rear of the setting, gives ample time for thorough and complete combustion.

Kroeschell Bros. Co., who manufactures this boiler, has had one of them in operation for about 9 months at its works at 440-472 W. Erie St., Chicago, Ill. This particular boiler, which generates steam for the entire plant, has a shell 5 ft. 6 in. in diameter by 18 ft. long, and contains 60 4-in. fire tubes, 18 ft. long, and 29 3½-in water tubes 18 ft. long. The draft is natural, and a test run under draft conditions which were below the average showed excellent economy and capacity. Doors placed at convenient points along one side wall afford an easy means of observing the condition of the gases as they pass from the rear to the front.

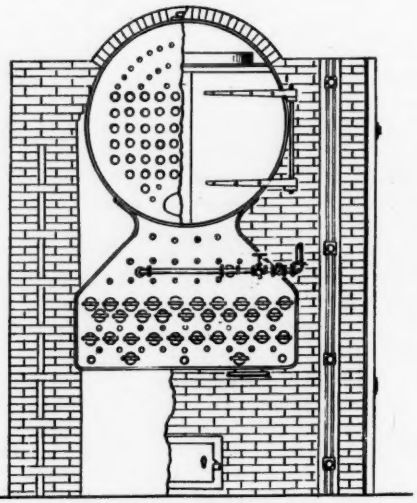


FIG. 2. REAR ELEVATION OF KROESCHELL BOILER, SHOWING FEED WATER CONNECTIONS

Cast-iron columns support the front end of the boiler, while the rear end, which rests on the back wall, is free to move on rollers as expansion or contraction may require.

Hollow stay bolts and individual handhole plates make inspection and cleaning easy, as all parts are readily accessible. Due to the positive circulation in this boiler, the makers claim for it a high efficiency and a large overload capacity. Its rapid steaming especially adapts it for fluctuating loads.

This boiler is rated by the builders on a basis of 10 sq. ft. of heating surface per boiler horsepower, and is built in standard sizes of from 100 to 350 hp.

ACCORDING TO THE BUFFALO EXPRESS President Richard Crick of the Niagara Falls Business Men's Association will appoint a committee of merchants to formulate plans for the organization and incorporation of an electric light and power company at Buffalo, N. Y. M. Arnson, a member of the committee appointed last year to investigate the possibilities of such a plant, said that Electrical Engineer H. B. Sweet of Utica reported that a plant sufficient for the needs of the merchants could be built for $60,000 and that current could be sold for 3 cents a kilowatt-hour, which is 2 cents under the price charged by the Buffalo & Niagara Falls Electric Light & Power Co.

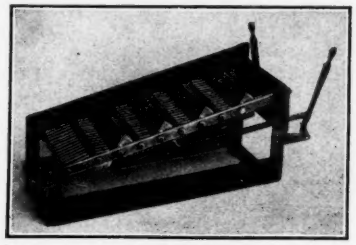
ALL PREDICTIONS OF PAST years that coal could not be worked at a greater depth than 1500 ft., no longer hold water. At the present day, according to W. E. Garforth, president of the British Institute of Mining Engineers, coal is being mined at depths exceeding 3000 ft. The adoption of a system of long-wall working has solved the question of superincumbent weight. The coal is exposed to this weight for a short time and places are closed up rapidly.—Compressed Air Magazine.

THE HUBER GRATE

IN this grate, shown in the accompanying cut, 2 trusses run lengthwise of the bars with the clips bridged across between trusses and regulated as to thickness and spacing according to the opening desired. One truss is made straight and the other deep and curved to give strength, prevent warping and avoid a large opening to waste fuel when the bar is rocked for shaking.

As shown, the bearing is placed off the center of the bar which gives an eccentric motion and rocks the bar toward the back of the furnace, thus working the coal back along the grate, which is inclined to the rear, and deposits clinker and ashes on the dump grate. The lift of the bar also sifts out the ashes and breaks up the fire.

Parts of the frame are held by interlocked tongue and groove so that no bolts are needed.



THE HUBER ROCKING GRATE STOKER

Two shaking levers permit of rocking the bars in alternate sets as in the cut, or both levers may be used, rocking all bars at once. By rocking the bars a few times before adding fresh fuel, the old fuel is moved toward the rear, and fresh coal may be added at the front, avoiding the labor of throwing fuel to the rear of the grate and preventing the mixing of fresh coal with ashes. Thus slicing is unnecessary and effective coking is secured for bituminous coals.

The bars can be raised from 1 to 5 in. in rocking, as may be found most efficient for the coal in use, and the dump grate may be thrown to clear clinker and ashes at any time, independent of the grate bars.

The Huber grate is made of by The Huber Grate Bar and Stoking Co., of Baltimore, Md.

NEW WESTINGHOUSE MAGNET SWITCHES

THESE switches have been designed especially with a view to obtaining continuity of operation for the controller on which they are used, so that every effort has been made not only to secure long life to the wearing parts but also to insure rapid repairs in case of accident.

The switches are of the clapper type and are arranged so that they are opened by gravity assisted by a spring. Direct-current switches are single-pole; alternating switches are 2-pole and can be supplied with 3 poles when desired.

Direct-current switches are made in both shunt and series forms. Each switch is mounted on an individual slate base so that in case of accident an injured switch can be replaced immediately.

The wearing parts, such as contacts, arc shields, etc., are in general the same in both alternating-current and direct-current switches of the same capacity, thus reducing the number of repair parts to be carried in stock by firms using both kinds to a minimum.

Special care has been taken to reduce the destructive action of the arc to a minimum. The arc when formed is not blown sidewise against the arc shield but is guided upwards by an arcing horn and is then extinguished by the blowout coil. This arrangement preserves both contacts and arc shields.

In closing, the contacts have first a wiping action, then roll against each other, and are finally firmly pressed together. In switches of 250 amp. capacity and larger the circuit is made and broken between copper and carbon, but in all cases the final contact is between copper pieces.

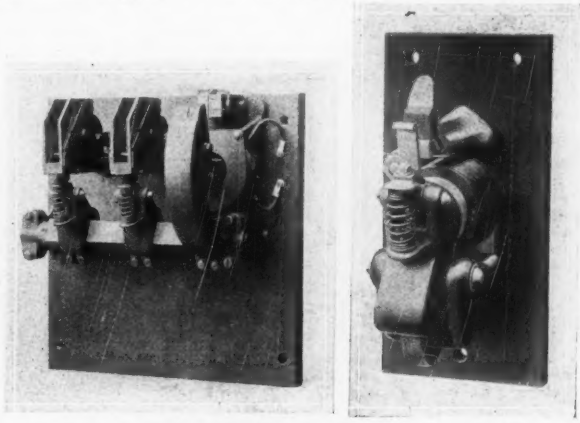


FIG. 1. WESTINGHOUSE MAGNET A.C. SWITCH
FIG. 2. DIRECT CURRENT SWITCH OF THE MAGNET TYPE

The flexible copper shunts which carry the current to the movable contacts are welded to the terminals; there is no solder to melt, run down the shunt and stiffen it on solidifying.

These switches are a recent development of the Westinghouse Electric & Mfg. Co.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for metallurgical engineer, for work in iron and steel. From the register of eligibles resulting, certification will be made to fill a vacancy in the Bureau of Mines, Department of the Interior, for service at Pittsburgh, Pa., at a salary ranging from $3000 to $4000 a year, and vacancies as they may occur in positions requiring similar qualifications. An educational training equivalent to that required for graduation from a college or university of recognized standing, such training to have included courses in chemistry, physics, and metallurgy, and not less than 6 years' experience in the metallurgy and operation of iron and steel mills, are prerequisites for consideration for this position. The applicant must have demonstrated a capacity for preparing reports as shown in manuscript reports or published papers. Applicants must have reached their 25th but not their 40th birthday on the date of the examination. Persons who desire this examination should at once apply for Form 304 and special form to the United States Civil Service Commission, Washington, D. C.; the secretary of the board of examiners, post office, Atlanta, Ga., San Francisco, Cal.; customhouse, New Orleans, La., Honolulu, Hawaii. In applying for this examination the title "Metallurgical Engineer (Male)" should be used.

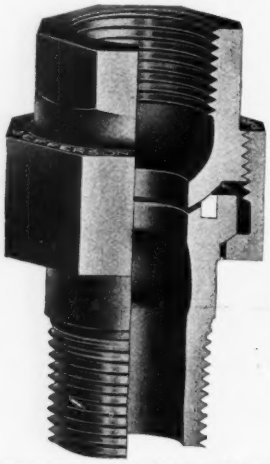
WHAT CHEER CHEMICAL CO., Pawtucket, R. I., is planning the erection of a new 3-story brick structure on Grotto Ave., south of plant of L. B. Darling Co. Work will include a power house and boiler room.

JEFFERSON SMALL NUT STYLE UNION

New Design for Use in Close Quarters

THOSE who have had pipe fitting to do in close quarters will appreciate the new style of union which has recently been developed by the Jefferson Union Co., which is called the small nut style. It is built suitable for working steam pressures up to 250 lb., and one of its most important features is the fact that where pipes are out of line, which is the case in many plants, especially where connections are made in out-of-the-way places, this union can be used in an equally efficient manner as if the pipes were absolutely straight. This feature is made possible by the ground ball joint.

Other features are the taper pipe threads, liberal play between swivel end and nut, and the externally threaded part has a round wrench hold. While this



PART SECTION OF JEFFERSON SMALL NUT STYLE MALE AND FEMALE UNION

union is so proportioned as to be as strong as other types of Jefferson unions, it is recommended for use only in cramped places where male and female unions are desired. The accompanying illustration shows clearly the construction and distinctive features of the union.

BOILER GRAPHITE FEEDER

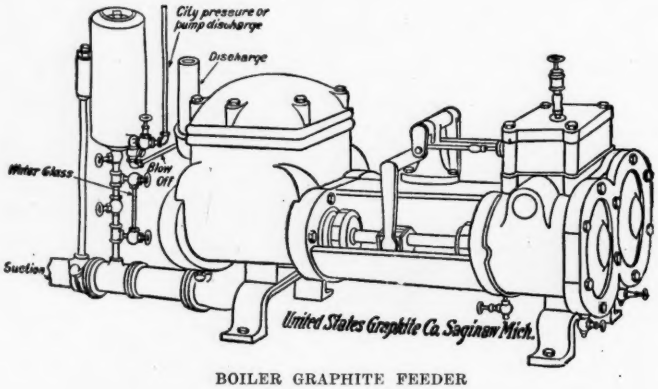
ILLUSTRATED herewith is a boiler graphite feeder provided with a reservoir which is so equipped with valves that it may be entirely closed and all water pressure shut off. The water valve is then opened so that the ordinary city water pressure is applied to the reservoir of the feeder and then this combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feed water on to the suction side of pump. This valve permitting the water saturated with graphite to pass through can be readily adjusted by watching the water glass to see how fast it is traveling. With a little experience the engineer soon becomes able to regulate this valve so that there will be, through the hours of operation, a constant leaching of graphite going into the boiler with the feed until the contents of the reservoir become exhausted when the valves are again closed and by means of a drain valve which is on the reservoir it is emptied to the clear water remaining in it and then again filled with graphite and regulated as before.

After a little experience and measuring of time the valve through which the graphite passes into the feed water can be set and marked so that the engineer will know just where to open it each time in order to give his dose as specified.

The illustration shows the manner in which the feeder is connected with the feed line at the suction side of pump. The United States Graphite Co. is prepared to supply this feeding device completely equipped with all valves and fittings to users of Mexican boiler graphite.

NEWS NOTES

UPON PILES DRIVEN OUT in the Maumee River will be built the plant which is to furnish power for the new Hocking Valley docks. Permit for the construction of the first permanent building on the Hocking Valley property in East Toledo was taken out recently. The permit calls for a building 42 by 113 ft. It will cost $12,000. This amount does not include the estimates for machinery and equipment, which will amount to more than $50,000.



BOILER GRAPHITE FEEDER

With sand and muck scraped from the bottom of the river by the dredges which have been working all summer off the shore near the new docks, a peninsula has been constructed almost in the center of the river. It extends from the east shore of the river out to the dock line, which is nearly to the edge of the present channel. A reinforced concrete wall has been built around the peninsula to guard against ice and high waters. Piling has been driven down to the solid earth under the river bed, and upon these piles the plant which is to furnish power for the huge loaders will be constructed.

Orders have been placed by the Hocking Valley Co. for 3 250-hp. boilers which will be installed in the new plant before the first of the year. In connection with the boilers will be generators and engines. While the loading machines will be operated by steam furnished at the plant, electricity will be generated for lighting purposes and possibly for motor switching apparatus in the yards. Work of dredging the slips for steamships and of cutting away the east bank of the river for yards is progressing rapidly. The Great Lakes Dredge and Dock Co. of Cleveland, which has the contract for the work, is rushing as much as possible in order to have the filling in the river completed before cold weather sets in and the water freezes.

THE COMMONWEALTH POWER CO. has ordered the Eastern Michigan Power company to construct an office and substation in Grand Ledge, Mich.

JOHN W. EMERY is estimating on plans and specifications for a stone and brick power house for the State Sanitorium for Tuberculosis, at Philadelphia, Pa. George S. Drew is the architect.

THE NEW POWER PLANT for the Elmira (New York) Water, Light & Railroad Co., is progressing rapidly, and it is expected that the plant of 12,000 hp. will be ready for service by the 1st of December.

BACHMAN & CO., 624 Stock Exchange Building, Philadelphia, Pa., has plans and specifications and is desirous of receiving bids on a gas and electric power-house, to be erected at Georgetown, S. C., also on a gas generating house to be erected at Gastonia, N. C.

THE CONTRACT FOR BUILDING the cement block power house of the Hirth-Krause Co., at Rockford, Mich., planned by Wernette, Bradfield & Mead, has been awarded to Fred Burgstahler; the contract for the steel stack, 4 ft. in diameter and 100 ft. high, goes to the Central Boiler & Supply Co.

FOR THE INSTALLATION of more machinery an addition will be built to the power house of the Lehigh Valley Transit Co., Allentown, Pa. The permit for the erection was granted recently to Contractor George H. Hardner and work will be rapidly completed. The permit calls for a one-story brick building, 20 by 40 ft.

THE SIXTH ANNUAL MEETING of the National Gas Engine Association will be held in Toledo, Ohio, December 4 to 6. No show of heavy machinery will be made, but tables will be provided for those who wish to exhibit accessories. The committee is busily at work on a program of papers and discussions, which promises to be of unusual interest.

JOSEPH HARRINGTON, who for a number of years has been the engineer for the Green Engineering Co., which manufactures Green Chain Grate stokers, has opened offices at 942 Consumers Building, Chicago, as advisory engineer in matters relating to the combustion of coal, and organization and equipment of the boiler room, with special reference to efficiency of the apparatus and economical production of steam.

PROVIDENCE ENGINEERING WORKS, of Providence, R. I., have secured the services of Albert E. Guy as mechanical engineer. Mr. Guy has just terminated a 2 years' engagement with Wilson-Snyder Centrifugal Pump Co., of Pittsburgh, Pa., as chief engineer, where he designed a complete line of single and multi-stage centrifugal pumps for steam turbine and motor drive.

APPLICATION FOR A FRANCHISE to use the streets for the setting of poles and stringing of wires over which to transmit electricity for power purposes has been made to the Salamanca, N. Y. authorities by the Olean Electric Light Co. This company, it is understood, is a branch of or closely affiliated with the Western N. Y. & Pennsylvania Traction Co. It has for some time been reaching out for new fields, and some months ago there was a rumor that the company was desirous of purchasing the electrical portion of Salamanca's municipal water and light plant.

WHILE CROSSING FROM ANTWERP to attend the meeting of the Consolidated Diesel Engine Manufacturers in London, Dr. Rudolph Diesel disappeared from the steamer Dresden and has not since been heard from. It is feared that his mind gave way under the worry from the discontinuance of the use of the Diesel engine in some large steamers, owing to the increase in the cost of fuel available. His work in the design and perfection of the Diesel engine is too well known to need comment. He was born of German parents, in Paris, in 1858, and educated in the German schools. The working out of his theory and construction of a rational heat motor, was completed in 1893, and immediately created a great sensation and was tried out in small engines, which proved so successful that the size was increased and the engine adapted for furnishing power for all kinds of work.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for chief metallurgist. From the register of eligibles certification will be made to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field (at Pittsburgh, Pa., or Denver, Colo.), at a salary ranging from $4000 to $4800 a year, and vacancies as they may occur in positions requiring similar qualifications. An educational training equivalent to that required for graduation from a school or college of mines, and at least 5 years' practical experience in actual mining, engineering, and metallurgical practice, are prerequisites. The applicant must have demonstrated a capacity for preparing reports and discussions of observations as shown in manuscript reports or published papers. Applicants must have reached their 35th but not their 50th birthday on the date of the examination. Apply at once for Form 304 and special form to the United States Civil Service Commission, Washington, D. C., using the title "Chief Metallurgist (Male)."

THE UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for aid, for men only, on November 5 and 6, 1913, at principal cities of the country. From the register of eligibles resulting, certification will be made to fill vacancies as they may occur in this position in the Bureau of Standards, Department of Commerce, at salaries of $600 and $720 a year. The work of the Bureau of Standards is scientific and technical in character, consisting principally of physics, chemistry, and mechanical and electrical engineering.

Competitors will be examined in elementary algebra, geometry, trigonometry, general physics, elementary mechanical drawing, education, training, and experience. Graduation from a mechanical training, technical, or scientific school or equivalent training in a scientific or technical laboratory is a prerequisite. Applicants must have reached their 19th but not their 24th birthday on the date of the examination. Persons who desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at principal cities, for application Form 1312. In applying for this examination the title "Aid (Male)" should be used.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for metallurgist, for work with smelter fumes. From the register of eligibles certification will be made to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field (San Francisco, Cal., or Denver, Colo.), at a salary ranging from $2700 to $3600 a year, and vacancies as they may occur in positions requiring similar qualifications. An educational training equivalent to that required for graduation from a college or university of recognized standing, and not less than 3 years' practical experience in the chemical and metallurgical phases of smelter operations in both copper and lead, and in the examination of smelter fumes, are prerequisites.

The applicant must have demonstrated ability as a writer of reports, as shown in manuscript reports or published papers. Applicants must have reached their 25th but not their 40th birthday on the date of the examination. Apply at once for Form 304 and special form to the United States Civil Service Commission, Washington, D. C., using the title "Metallurgist (Male)."

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for assistant metallurgist. From the register of eligibles certification will be made to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field (at San Francisco, Cal., or Great Falls, Mont.), at a salary ranging from $2000 to $3000 a year, and vacancies as they may occur in positions requiring similar qualifications. An educational training equivalent to that required for graduation from a college or university of recognized standing, and not less than 3 years' experience in chemical and metallurgical work in smelter operations, or not less than 1½ yr. at such chemical and metallurgical work and 1½ years' experience in metal mining operations, are prerequisites. The applicant must have demonstrated ability to prepare reports as shown in manuscript reports or published papers. Applicants must have reached their 25th but not their 40th birthday on the date of the examination. Apply at once for Form 304 and special form to the United States Civil Service Commission, Washington, D. C., using the title "Assistant Metallurgist (Male)."

BOOK REVIEW

POWER PLANT TESTING, by J. A. Moyer, New York, 1913, 486 pages, fully illustrated, 6 by 9 in. Cloth binding, price, $4.

This is the second edition of a book intended to give full details in regard to testing apparatus, and methods of testing in power plants. While the divisions do not correspond exactly with the chapters, it may be roughly divided into: the elements of measurements and instruments; tests of individual apparatus; tests of plants, or sections of plants. The commercial testing apparatus is quite completely described, with details of construction and methods of use, and how each kind of instrument can be utilized to advantage, is fully shown. The treatment of testing the steam engine indicator, and of testing the correctness of reducing motions, may be mentioned as being particularly good, also the treatment of errors of indicator diagrams, their causes, and what peculiar forms of diagrams indicate as to the valve setting and other action of the engine. A complete explanation is also given of the action of the planimeter, and how it accomplishes its work of measuring plane areas. Full description is given of different kinds of brakes for absorbing power, and the adaptability of different kinds for various speeds and powers. Considerable mathematics is used throughout the book, but it is not of a kind which would be classed as difficult. In testing of plants and sections of them, the methods given are a condensation of the standard methods adopted by the American Society of Mechanical Engineers, and the reasons for putting them into book form do not quite seem apparent, as these are available in their full contents in pamphlets from the Society direct. It does give, however, in convenient form, a reference book on the matter of testing out power plants and apparatus, and combines into one book material which otherwise would have to be sought from a number of different sources.

PHYSICAL MEASUREMENTS, by E. W. Duff and A. W. Elwell, Philadelphia, 1913; 140 pages, with connection diagrams, 5 by 8 in. Cloth binding, $1.50.

This is largely a guide in making of physics experiments, for the purpose of training the student in careful use of instruments and delicate apparatus, and in reporting and comparing results from such tests. It is apparently designed primarily as a text for high schools and college courses, but covers a wide range of experiments. The bibliography of reference to other works is particularly good and complete, and the instructions for making tests of physical constants for practice, in order to get the method of using instruments, and to get the methods of making investigations, are clearly put and show a full understanding of the requirements of the student.

HEATING SYSTEMS, by F. W. Raynes, New York, 1913, 328 pages, illustrated, 5 by 8½ in. Cloth binding, $3.50.

A very complete book is here presented, on the design of hot water and steam heating apparatus, with full descriptions of the different systems in use, the apparatus employed in those systems, and a series of charts, of capacities, for hot water systems, risers, capacities of pipe, drop in temperature and size of pipe required, which are well designed to save figuring, in designing and estimating for plants. A similar series of charts is provided for the steam system, for varying pressures. Supplementing these are tables and charts showing the sizes of boilers needed, and the size of chimney for the plant, and short chapters are added on temperature regulation. It is a book well suited as a work of reference for the man who has much business to do, as well as to the student.

CATALOG NOTES

THE GENERAL ELECTRIC CO. has recently issued Bulletin No. 4972, describing the KR System of Voltage Regulation, which can be successfully employed on systems having such large fluctuations of voltage that the standard method is ineffective. The KR system comprises a booster, combined with an automatic regulator so arranged as to reverse continually the excitation of the booster, but with varying periodicity. The theory of the system is analyzed in the bulletin and a diagram illustrating its application is shown.

N. T. C. BULLETIN No. 17, "The Manufacture and Use of Shelby Seamless Steel Tubing," contains extracts from an address to the U. S. Naval School of Marine Engineering, Annapolis, Md. Illustrations show the manner of forming various articles from Shelby seamless steel tubing. Two pages are devoted to "Some Uses of Shelby Seamless Steel Tubing." Comprehensive information not generally found in either technical books or trade papers will no doubt prove of interest to readers, any of whom will be supplied with a copy at request to National Tube Co., Pittsburgh, Pa.

A NEW CATALOG describing Sturtevant airwashers has just been issued by the Sturtevant Co. This catalog contains 40 pages and describes the airwasher and its uses. It also contains illustrations of the various parts, valuable psychrometric tables and an excellently arranged psychrometric diagram, together with a table of sizes and capacities of the Sturtevant airwasher. This catalog may be obtained by addressing the B. F. Sturtevant Co., Hyde Park, Boston, Mass.

BULLETIN NO. 301, from Pawling & Harnischfeger Co., gives a detailed description and the uses of a new hoist manufactured by that company.

ICE AND REFRIGERATING machinery manufactured by Huetteman & Cramer Co., Detroit, Mich., is described in an illustrated pamphlet devoted to the company's "Safety" compressor.

THE WM. POWELL CO., Cincinnati, O., has just issued a booklet on "Powell" Grease Cups, describing new designs and illustrating its complete line. Copies will be mailed to any engineer on request.

FROM MORRIS MACHINE WORKS, Baldwinsville, N. Y., we have received the company's latest catalog, which contains 126 pages on Morris centrifugal pumps, hydraulic dredges and steam engines. Several pages furnish useful data in hydraulics, etc.

A CONTINUOUS FEED is secured with a valve of the Williams Safety regulator, which performs the duties of a water column, safety alarm column and feed water regulator. Several types of these regulators are illustrated in a booklet from Williams Gauge Co., Pittsburgh, Pa.

WHERE AND HOW the Vogt ice and refrigerating machinery is made and used is discussed in an 80-page illustrated catalog from Henry Vogt Machine Co., Louisville, Ky.

Bulletin F-1 from the same company deals with forged steel valves and fittings for ammonia, steam and hydraulic work.

"NATIONAL" SPRING PLUG COCK suitable for working pressures up to 125 lb., made in different metals for varying service, is described and illustrated in a circular just received from National Tube Co., Pittsburgh, Pa. Copies of the circular will be sent on request.

THE FRANKLIN water-tube boiler, built by the Nagle Engine & Boiler Works, Erie, Pa., is described and illustrated in a catalog from that company.

Circular No. 75 announces the purchase of the boiler which was formerly built by the Franklin Boiler Works Co., and discusses points of excellence.

GRINNELL AUTOMATIC SPRINKLER Bulletin No. 74 discusses various devices for escape from and control of fires, also a demonstration of sprinkler supervisor service given at the Convention of Fire Engineers at the Grand Central Palace in New York. The pamphlet is published by the General Fire Extinguisher Co., Providence, R. I.

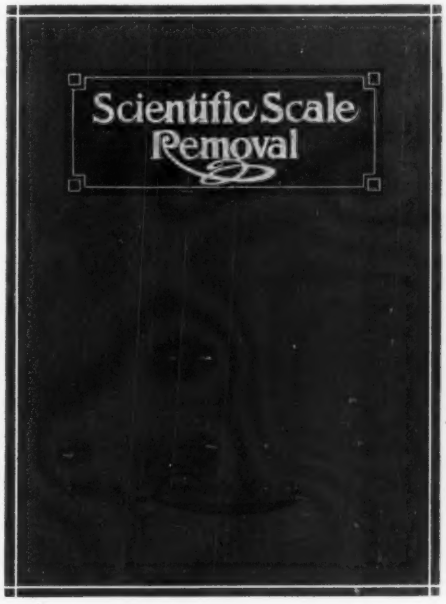
THE INGERSOLL-RAND CO., 11 Broadway, New York, has just issued an 8-page bulletin, form 8011, showing a new line of "Little David" riveting hammers, sizes 50, 60 and 80, suitable for structural work, tank, steel and any other work up to 1¼-in. diameter rivets. Booklet is illustrated to show the hammer at work.

"Calyx Bore Holes" is the title of a small booklet, form 632, from that company which is descriptive of the line of Calyx drills manufactured by them. The catalog shows the sizes and capacities, and the different style machines are illustrated by half-tone illustrations.

TO ASSIST DEALERS in making sales of Mazda lamps, the Mazda Electric Lamp Association is sending out a series of window displays illustrating welfare work at the research laboratories, the testing laboratories, and the workshops at Nela Park, Cleveland, Ohio, and also a folder is included giving full instructions for a publicity campaign to induce people to light with Mazda lamps.

CATALOG 21, entitled "Steam Specialties for Power Plants and Steam Heating," was recently issued by W. D. Allen Mfg. Co., 185 W. Lake St., Chicago.

"SCIENTIFIC SCALE REMOVAL" is the title of a handsome 24-page catalog, recently issued by the Lagonda Mfg. Co., of Springfield, Ohio. It deals mainly with externally driven mechanical cleaners, for removing scale from the tubes of boilers, condensers, economizers, etc. The harmful effects of scale in boilers, and the benefits accruing from its periodic removal are also touched upon, and the large number of photographs showing how the mechanical cleaner has been adapted to meet conditions in different plants, should interest all engineers. The other products of the Lagonda Mfg. Co., such as the water strainer, reseating machine, automatic cutoff valve, tube cutter, and the various types of air and water turbine cleaners are also briefly described. This catalog will form a



valuable addition to every engineer's library, and will be sent upon request by addressing the company as above.

"THE STRENGTH OF I-BEAMS in Flexure," by Herbert F. Moore, has just been issued as Bulletin No. 68 by the Engineering Experiment Station of the University of Illinois.

No structural steel shape is in more common use than the I-beam. Engineers, in computing the load-carrying capacity of I-beams, have, in general, used formulas based on theoretical considerations and upon the tensile strength of steel, and the results of actual tests of I-beams have not been widely used.

An I-beam may fall in various ways; by direct flexure, by sidewise bucking or failure may occur in the web. This bulletin discusses the various methods of I-beam failure, describes and tabulates the results of tests of I-beams made at the University of Illinois and at other laboratories and gives proposed formulas for the strength of I-beams against sidewise bucking and against web failure.

Copies of Bulletin No. 68 may be obtained upon application to C. R. Richards, Acting Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

IN THE CATALOG describing corrugated copper expansion joints, just issued by E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass, we find 2 tables of value to operating engineers who may have occasion to make changes in their steam lines. The first of these tables gives the lengths of pipe cared for by a standard Badger expansion joint for different pressures. This table is as follows:

Length of Pipe Cared for by a Standard Joint.

Gage Pressure	Cast-Iron Pipe	Steel Pipe
5	115	100
15	100	90
25	90	80
50	110	90
80	100	85
125	90	75
150	85	70

The company will be glad to send a copy of this catalog to anyone asking for it.

BULLETIN NO. A4137, recently issued by the General Electric Co., illustrates and describes that company's Curtis steam turbines of 100 to 2500 kw. capacity, for driving 60-cycle generators at 3600 r.p.m. These generating sets are of the horizontal shaft rigid frame style, and either 2 or 4 impulse wheels are used, depending upon the capacity of the generator. These sets include all the latest developments in the Curtis steam turbine, and represent the most advanced stage in turbo-generator construction. The shaft packing is steam sealed and is capable of maintaining a high vacuum indefinitely. The governor is of the centrifugal-inertia type and controls the valves through a relay which relieves the governor of the necessity of supplying the power to operate the valves. The steam admission valves operate in sequence, and do not throttle or wire-draw the steam. As an added factor of safety an emergency governor is supplied, which is entirely independent of the steam regulating governor.

The bulletin is profusely illustrated, showing details of turbine construction, path of steam flow, and a number of typical installations.

THE TWENTY-SECOND ANNUAL Revised Edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. Established in 1891, it has been published annually since that time. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. The present is by far the most complete edition of this work so far published. The twenty-first edition required 122 pages to index its contents, while the twenty-second edition requires 138 pages, or 16 additional pages. As there are upwards of 400 classifications on each page, the 16 additional pages represent the manufacturers of over 6000 articles, none of which have appeared in any previous edition. The total number of classifications is over 55,000, each representing the manufacturers or dealers of some machine tool, specialty or material required in the architectural, engineering, mechanical, electrical railroad, mine and kindred industries. This edition numbers 1635 pages. Classifications are so arranged that the book can be used for either purchasing or mailing purposes. The book is revised, improved and issued annually. It is expressed to any part of the country on receipt of $10 by the publishers, S. E. Hendricks Co., 74 Lafayette St., New York.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price $1.75 a year.

Foreign Countries, subscription price $2.50 a year.

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

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Technical Publishing Co.

537 S. Dearborn Street

Chicago

Positions Wanted

POSITION WANTED—By experienced gasoline engineer. Prefer small light or pumping plant. Understand steam and electricity. A. S. C. student. Close attention to business. Oliver W. House, Rush Springs, Okla. 11-1-1

POSITION WANTED—Chief engineer, accust. to have charge of large power stations, Steam, Producer gas and Blastfurnace gas. Good on tests, coal and gas analysis. Power house design and construction. Technical education and practical experience. References. Open for engagement. Address Box 323, Practical Engineer. 11-1-3

POSITION WANTED—By young man as assistant engineer in lighting or power station. I can furnish best of reference. Ernest Walker, 81 7th Ave., Cedar Rapids, Ia. 11-1-1

POSITION WANTED—Machinist, Engineer or Master Mechanic. Was erecting engines for Ingersoll-Rand Co. six years. First class man on all kinds of engines, air compressors and pumps. Can indicate and do all repairs; will go anywhere. Age 35. Address Box 317, Practical Engineer.

POSITION WANTED—By first-class Steam Engineer. A. and D. current. Can give results and best of reference. Sober and steady, 14 yrs.' experience. Address Box 309, Practical Engineer, Chicago, Ill. 10-1-2

POSITION WANTED—Experienced salesman, 27, American, forceful and energetic, good personal appearance, desires connection with manufacturer as traveling representative in any territory. Wishes to learn line thoroughly so that success will be positive. Substantial references and surety bond. Address Salesman, No. 181 Mercer St., New York, N. Y. 10-15-2

POSITION WANTED—By a refrigeration engineer, who is a first class mechanic and understands thoroughly the economic operation, management, overhauling and repairing of a refrigeration plant, and has the energy and the ability to make good. Six years in present position. W. E. H., Box 318, Practical Engineer. 10-15-2

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old established manufacturer in the power plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—Every local Engineers' Association to have an assortment of valuable power plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED—Secretary of local Engineers' Association to write us at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

WE WANT to sell manufacturers products. Give us prices, terms and territory. Offices in New York, Chicago, San Francisco, New Orleans and Butte, Mont. Address Box 325 Practical Engineer. 11-1-2

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf

WANTED—WORKING FOREMAN to take full charge of light and power and repairs in large plant in Middle West. Must be familiar with gas engines, electrical apparatus, cranes, compressors, etc. Good opportunity for capable hustler. State experience, condition of health, age and salary required. Address Box 320, Practical Engineer. 10-15-2

For Sale

FOR SALE—One (1) Hornsby-Akroid Patent Safety Oil Engine, horizontal, single cylinder, 16 H.P., with silencer, lamp, stand and drip pan. Used 6 years and in good condition. Address L. Lehman & Company, Trenton, N. J. 11-1-1

BOILER BARGAINS—Three New 175 each 72 inches by 20 feet Biglow Stationary Boilers, 150 pounds pressure. One second-hand 200 H. P. 78 inches by 20 feet Stationary Boiler 125 pounds pressure. Engineer, Box 4, Clifton, Cincinnati, Ohio. 10-15-2

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 11-1-1

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf

PATENTS SECURED. Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Building, Washington, D. C. tf

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf

Educational and Instruction

ENGINEERS' POCKET MANUAL. 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather.

Miscellaneous

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water Purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf

Sparks On The Advertising Pages

Mother Nature, in the plan of Creation, must have foreseen the necessity for advertising, when she gave mankind the most powerful of all advertising mediums—*the human tongue.*

"Set the tongue to wagging," said a prominent advertiser, "and you have set in motion an advertising force which reaches the family circle of rich and poor, learned and illiterate, alike."

In the olden days, one of the methods of advertising was the use of *criers.* Men traversed the streets of the cities, ringing bells to attract attention, and vocally called the wares carried by the merchant on Such-and-Such street.

But the world has grown and progressed, and with the addition of millions to the civilized and educated portion of the population, newer methods became necessary to get merchandise *talked about.* Printed advertisements were the result.

The fundamental dual purpose of printed advertising is to cause the mind to think and the tongue to talk. The merits and accomplishments of the article are brought forth in print, as a *course,* or a *route,* along which the verbal advertising is to follow.

In brief, the modern relation of printed advertising to word-of-mouth advertising may be likened to the relation of an *exciter* to a *main alternating current generator.* Without the exciter, the generator will not furnish current. Without printed advertising, there is no field current for the tongue advertising.

A concrete illustration of how advertising methods are originated with a view of starting the tongue, is that used by Herbert N. Casson, one of America's foremost Advertising and Efficiency Men. The New York Telephone Company desired to *quickly* call the attention of the residents of Buffalo to some new improvements in service. Mr. Casson suggested that for the next six weeks, all money paid out by the company be *mint-new.*

The company paid out $4000 a day, and as there is very little actual money in circulation in any city, Buffalo was soon bathed in a flood of bright shiny silver and crisp greenbacks. At the end of the time, advertisements appeared, headed "Have You Noticed The New Money," and followed by a talk about the new telephone improvements. The effect was electrical.

The very fact that printed advertising is aimed to create talk is *a buyer's* best protection—your protection. The National Advertiser, desirous of building or continuing a permanent business, is careful not to insert in his printed advertising any claim or statement which is not fully proven by the article itself.

The same power—the tongue—that creates an advertising success *can cause it to fail.* You perhaps can immediately call to mind a purchase you had intended to make until a friend's adverse criticism caused you to change your mind.

Just remember that the Advertisers in Practical Engineer want your good opinion. They want your tongue to advertise for them after you have purchased. The best quality possible is put into their products. *Therein, lies one of the values of buying only products which are advertised.*